DTRA-TR-00-9

Technical Report

CATS User's Manual

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March 2004

Prepared for:
Defense Threat Reduction Agency
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Fort Belvoir, VA 22060-6201

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13. ABSTRACT *(Maximum 200 words)*

The Consequences Assessment Tool Set (CATS) addresses the need to predict damage and analyze consequences from natural and technological disasters. Winner of numerous awards, including the 1996 Ford Foundation Innovations in American Government Award, CATS employs a suite of hazard, casualty and damage assessment modules to estimate and analyze effects of natural phenomena, such as hurricanes and earthquakes, and technological disasters, such as terrorist incidents, involving weapons of mass destruction, and industrial accidents. CATS depicts damage extent, probabilities and numbers of fatalities and injuries, and mitigative resource allocation. CATS operates on Pentium PCs running Windows 95/98/NT 4.0, and is integrated within the commercially available Arcview® Geographic Information System (GIS). CATS uses the power of the GIS to display and analyze hazard predictions, perform consequences assessment, facilitate resource management and create pictorial and textual reports. This report provides user instructions and a technical description of the code architecture.

14. SUBJECT TERMS

WMD	Initial Radiation	Residual Radiation	Toxic Industrial Materials	Hazards
Fallout	Biological Agents	Chemical Agents	Emergency Management	Consequences
Hurricanes	Storm Surge	Earthquakes	Oil Spills	
	Population Effects	Population at Risk	Infrastructure at Risk	

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CONVERSION TABLE

Conversion Factors for U.S. Customary to metric (SI) units of measurement.

MULTIPLY → BY → TO GET
TO GET ← BY ← DIVIDE

angstrom	1.000 000 x E -10	meters (m)
atmosphere (normal)	1.013 25 x E +2	kilo pascal (kPa)
bar	1.000 000 x E +2	kilo pascal (kPa)
barn	1.000 000 x E -28	meter^2 (m^2)
British thermal unit (thermochemical)	1.054 350 x E +3	joule (J)
calorie (thermochemical)	4.184 000	joule (J)
cal (thermochemical/cm^2)	4.184 000 x E -2	mega joule/m^2 (MJ/m^2)
curie	3.700 000 x E +1	*giga bacquerel (GBq)
degree (angle)	1.745 329 x E -2	radian (rad)
degree Fahrenheit	$t_k = (t^\circ f + 459.67)/1.8$	degree kelvin (K)
electron volt	1.602 19 x E -19	joule (J)
erg	1.000 000 x E -7	joule (J)
erg/second	1.000 000 x E -7	watt (W)
foot	3.048 000 x E -1	meter (m)
foot-pound-force	1.355 818	joule (J)
gallon (U.S. liquid)	3.785 412 x E -3	meter^3 (m^3)
inch	2.540 000 x E -2	meter (m)
jerk	1.000 000 x E +9	joule (J)
joule/kilogram (J/kg) radiation dose absorbed	1.000 000	Gray (Gy)
kilotons	4.183	terajoules
kip (1000 lbf)	**4.448 222 x E +3**	newton (N)
kip/inch^2 (ksi)	6.894 757 x E +3	kilo pascal (kPa)
ktap	1.000 000 x E +2	newton-second/m^2 (N-s/m^2)
micron	1.000 000 x E -6	meter (m)
mil	2.540 000 x E -5	meter (m)
mile (international)	1.609 344 x E +3	meter (m)
ounce	2.834 952 x E -2	kilogram (kg)
pound-force (lbs avoirdupois)	4.448 222	newton (N)
pound-force inch	1.129 848 x E -1	newton-meter (N-m)
pound-force/inch	1.751 268 x E +2	newton/meter (N/m)
pound-force/foot^2	4.788 026 x E -2	kilo pascal (kPa)
pound-force/inch^2 (psi)	6.894 757	kilo pascal (kPa)
pound-mass (lbm avoirdupois)	4.535 924 x E -1	kilogram (kg)
pound-mass-foot^2 (moment of inertia)	4.214 011 x E -2	kilogram-meter^2 (kg-m^2)
pound-mass/foot^3	1.601 846 x E +1	kilogram-meter^3 (kg/m^3)
rad (radiation dose absorbed)	1.000 000 x E -2	**Gray (Gy)
roentgen	2.579 760 x E -4	coulomb/kilogram (C/kg)
shake	1.000 000 x E -8	second (s)
slug	1.459 390 x E +1	kilogram (kg)
torr (mm Hg, 0° C)	1.333 22 x E -1	kilo pascal (kPa)

*The bacquerel (Bq) is the SI unit of radioactivity; 1 Bq = 1 event/s.
**The Gray (GY) is the SI unit of absorbed radiation.

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SECTION 1

INTRODUCTION

1.1 OVERVIEW.

The Consequence Assessment Tool Set (CATS) assesses the consequences of technological and natural disasters to population, resources and infrastructure. Hazards accounted for in CATS range from natural disasters such as hurricanes and earthquakes, to technological disasters such as industrial accidents, terrorism and acts of war.

A user-friendly software package for the PC, Windows 95/98 and NT, CATS combines state-of-the-art hazard and consequence prediction, digital databases and a Geographic Information System (GIS) within an easy-to-learn Graphical User Interface (GUI). Developed under the guidance of the US Defense Threat Reduction Agency (DTRA) and the US Federal Emergency Management Agency (FEMA), CATS provides significant assistance in emergency managers' training, exercises, contingency planning, logistical planning and calculating requirements for humanitarian aid.

CATS predicts the damage and assesses the consequences associated with that damage as a result of a technological or natural hazard. The technological portion of CATS provides for the calculation of damage and consequence using real-time weather and a variety of sources, particularly those associated with weapons of mass destruction (WMD), as employed by military forces or terrorists. User-friendly GUI's and pre-defined event scenarios assist the CATS user in predicting credible hazards resulting from the dispersal of radiological, biological and chemical agents, regardless of the user's level of expertise and access to information.

The natural hazard portion of CATS provides for the calculation of damage and consequence from earthquakes and hurricanes. The earthquake model is a collection of programs that models the severity and the geographical extent of the damage due to the primary earthquake hazard of ground shaking as well as to the collateral hazards of ground failure, tsunami, and fire following the earthquake. The consequence of a damaging earthquake is assessed in terms of the facilities, infrastructure, and population at risk. The hurricane model predicts the tracking of the storm and the damage to the areas surrounding the track of the hurricane caused by the wind. The model ingests hurricane observation and forecast data provided by the National Hurricane Center (NHC) in Miami, FL, the Central Pacific Hurricane Center (CPHC) in Honolulu, HI, or the Joint Typhoon Warning Center (JTWC) in Guam in the form of Marine Forecast/Advisory Messages. In addition to the earthquake and hurricane models, the collection of natural hazard models includes a storm surge and hurricane uncertainty module.

CATS emphasizes the calculation and analysis of consequences, not merely the display of hazard distributions. It contains models for converting hazard spatial and temporal distributions into probabilities of casualties, including both mortality and morbidity. These probabilities can be created for diverse exposure scenarios, including time-varying protective measures. CATS also identifies and locates resources required for an effective, sustained response and recommends the most effective roadblock distribution to prevent unauthorized access to the affected area.

CATS operates within a full featured GIS. This means that the GIS acts as an operating system for the CATS application. The GIS environment allows the user to do far more than merely display graphical representations of hazard footprints on map backgrounds. Rather, CATS analytical tools enable the user to combine multiple layers of information, hazards, casualty probabilities and populations, to determine total number of persons effected, as well as levels and extent of property damage and event impact on the infrastructure. It provides the flexibility to incorporate a wide range of user-specific, geo-referenced and attributed, infrastructure, resource and facility data bases, all within the spatial context of geo-referenced vector, raster and photographic images.

1.2 REPORT ORGANIZATION.

In addition to this Introduction, this report contains nine sections and five appendices, as follows:

Section 2 describes the process of getting started, including tips on the installation of CATS and a brief overview of running the code for the first time.

Section 3 describes the operation of the CATS Project Screen, which may be termed the "house keeping" center for CATS. From the Project Screen, the user may open, close, or save a current project. The user may also obtain access to the major functional features of ArcView, which is the basis of CATS. These features include Views, Tables, Charts and Layouts. Of these the most important is the View, within which the majority of CATS functions are performed. This includes the creation and analysis of hazard and casualty probability distributions. Within the Project Screen the user may open Views or create and name new Views.

Section 4 describes the operation of the CATS View Screen. As noted above, the View Screen is the most important of all the CATS graphic environments. The centerpiece of the View Screen is the View Window, within which reside graphic representations of Themes chosen for display and analysis. Such Themes include raster and vector maps, other specific items describing the region, such as population distributions and addresses by street, and, finally, the distributions of hazards and casualty probabilities, which may be used to assess damage and injury.

Section 5 describes the calculation of technological hazards and casualty probabilities. Technological hazards are divided into three general types, unknown, toxic industrial materials and weapons of mass destruction. CATS provides the ability to deal with the unknown hazard through the creation of a object of arbitrary size and shape. This object may be used to perform many of the consequence assessment analyses described in Section 7. CATS provides a variety of tools to define toxic industrial material hazards from known sources. Listed from least to most sophisticated, these tools include North American Emergency Response Guide (NAERG) hazard areas, D2PC from the Army's Federal Emergency Management Information System, Areal Locations of Hazardous Atmospheres (ALOHA) from the EPA, NOAA and the National Safety Council (NSC), and the Hazard Prediction and Assessment Capability code (HPAC) created by the Defense Threat Reduction Agency (DTRA). Calculations for the WMD models are divided into two sections, CHAS and HPAC. CHAS, which stands for Comprehensive Hazard Assessment Software, allows a user, otherwise untrained in the science of hazard assessment, to generate distributions of radiation intensities or concentrations of biological or chemical agents using predefined event types, combined with current weather information. Terrorist events include explosive dispersal of agents from large and small canisters, as well as ground and aircraft sprayers. Military events in CHAS include deployment of all manner of munitions, delivering nuclear, biological and chemical warheads in credible spatial distributions. The HPAC option allows the experienced CATS user to vary a large number of input parameters, describing munitions, agents and their manner of deployment, as well as environment variables, including multi-dimensional wind fields. Finally, CATS provides a Rapid Hazard Assessment tool, which allows the user to create technological hazards with near "Point and Click" ease, using many of the models mentioned above.

Section 6 describes the calculation of natural hazards and casualty probabilities. The hurricane model predicts the tracking of the storm and the damage to the areas surrounding the track of the hurricane caused by the wind. In addition to the hurricane damage model, description of a separate model for damage as a result of surge from the hurricane is contained in Section 6. This section also contains the description for the hurricane uncertainty model. The uncertainty calculations allow users of CATS to determine damage probabilities as a function of the uncertainty associated with a given hurricane track forecast. Section 6 also contains description on how to perform earthquake model calculations. Detailed description of the parameter inputs required to perform model runs are covered.

Section 7 describes the use of the consequence analysis capabilities of CATS. Consequences include persons affected, as well as persons, infrastructure and housing units at risk. Total numbers of persons affected or at risk in various categories can be determined using either point, polygon or gridded population data bases. CATS also calculates street address locations of hazard extent, for use in emergency management.

Section 8 describes the use of the response resource sustainability (RRS) analysis capabilities of CATS. RRS analysis allows the user to estimate amounts of critical supplies required to respond to an emergency and to determine the extent of the required logistical infrastructure. The RRS section of CATS also provides for the identification of optimized road block sites to facilitate hazard area access control.

Section 9 describes the manner in which data bases may be modified and new data bases registered for use in CATS.

Section 10 describes the means by which graphical reports from CATS may be created and exported for use in other applications.

Appendix A describes the hurricane hazard and damage models, which are unique to CATS.

Appendix B provides descriptions of default parameters for technological hazards involving chemical and biological weapons of mass destruction.

Appendix C provides the metadata, i.e., key words, that describe the contents of many of the data bases provided with CATS.

Appendix D describes the organization and design of the CATS code system, including modules, calls and arguments, unique to CATS, that provide dialogues for directing code operation, initiate operations inside and outside CATS and report text or graphic results.

Appendix E provides forms for requesting additional copies of CATS software.

SECTION 2

GETTING STARTED

The CATS code system consists of both Commercial and Government Off-The-Shelf software (COTS and GOTS), plus the CATS Product, which includes the CATS application, executable and support files, and data base files. The recommended CATS working environment is as follows:

- **Hardware** – 3.6 GB (2.5 GB minimum) available hard disk storage, 32 MB RAM (Windows 95/98), 64 MB RAM (Windows NT)
- **Operating System** – Windows 95/98 and Windows NT
- **Required Supporting Software** - ArcView Geographical Information System (Version 3.1), ArcView Spatial Analyst extension (Version 1.1), products of ESRI, Inc.
- **Optional Supporting Software** – ArcView Streetmap, a product of ESRI, HPAC (Hazard Prediction and Assessment Code, Version 3.1 or 3.2, Defense Threat Reduction Agency) and ALOHA (Areal Locations of Hazardous Atmospheres, Version 5.2.1, National Safety Council)

The recommended disk storage includes all GOTS and COTS, all geographic population and other infrastructure data supplied with CATS, as well as room for files generated in using the code system. As noted, it is possible to install CATS in less space, with some data and functionality omitted.

2.1 CODE ORGANIZATION.

The architecture of the CATS code system is illustrated in Figure 1. GOTS and COTS components are shown in boxes with dashed outlines. Components of the CATS Product are shown in boxes with solid outlines. The default location of ArcView is the ESRI directory. Secondary components of CATS, HPAC and ALOHA, normally reside in directories of the same name. CATS may be operated without HPAC and ALOHA, buts their inclusion is highly recommended.

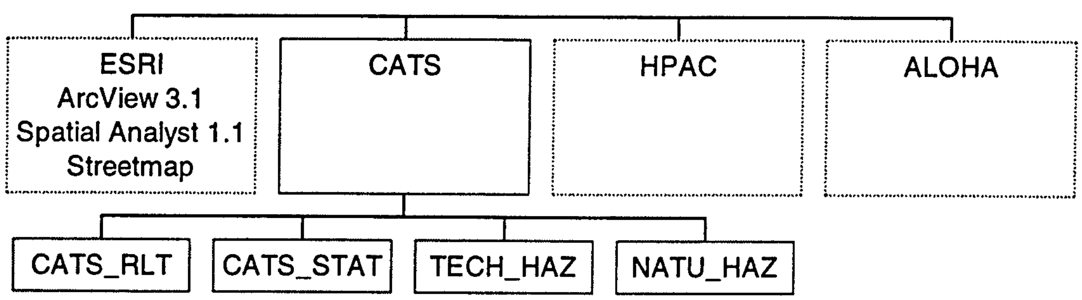


Figure 1. CATS directory organization.

The CATS directory contains the CATS application in the form of an ArcView project file (*.apr). The name of the file identifies the version of the code and the current build or modification level in the format *CATS[Version Number][Build Number].apr,* for example: CATS452.apr indicates version 4, build 52. Beneath the CATS directory are four subdirectories. CATS_RLT contains real-time data and software for retrieving the data and preparing them for use or display in CATS. Real-time data include current weather, hurricane warnings and earthquake bulletins. CATS_STAT contains static data bases and supporting software. Static data bases are those which do not change during CATS execution or are updated at intervals of a year or more, i.e., population distributions, political boundaries, infrastructure descriptions and locations, etc. CATS_STAT is the largest component of CATS in terms of storage requirements. The TECH_HAZ and NATU_HAZ directories contain the executable programs, supporting files and data required to predict the extent, intensity and severity in terms of casualty and damage probabilities for technical and natural hazards, respectively. Technical hazards may result

from the release of toxic industrial materials and from the deliberate or accidental use of weapons of mass destruction. Natural hazards currently treated by CATS include hurricanes, storm surge and earthquakes.

2.2 INSTALLATION

CATS code system components should be installed in the following order:

Install ArcView Version 3.1, then Spatial Analyst Version 1.1 extension and ESRI Streetmap extension, according to instructions supplied with those software packages.

Copy the directories HIGHWAY and STREETS from the ESRI Streetmap data CDROM to a hard disk location; [drive]:\esri\esridata\ is a good choice, but these directories may be placed on any accessible drive, so long as they are together in the same directory. ESRI Streetmap data may also be accessed on the CDROM drive, however this is not recommended because of retrieval speed limitations.

Install HPAC (Version 3.1 or 3.2) and ALOHA (Version 5.2.1) according to instructions supplied with these software packages. For use with CATS, detailed maps need not be installed in HPAC, however, installation of climatology and terrain files is recommended. HPAC and ALOHA do not have to be installed on the same PC drive as ArcView, the CATS product or each other.

Install the CATS product, as described in Section 2.3, below. The CATS installation set consists of the Installation CD (PC: W95, W98, WNT) and a Polygon Population Data CD.

Installation CD (installed size 1350 MB (World) or 920 MB (CONUS)) contains all files required to operate most CATS functions, including the complete set of CATS_STAT data to represent either the entire world or an area limited to the contiguous continental United States (CONUS). It does not include the 1990 Census Block Group Polygon Population data organized by state.

Polygon Population Data CD contains area-distributed census population data for CONUS by state, amounting to 563 MB. Within states each census block group area is described as a polygon, over which the population is uniformly distributed. These data may be used from the CDROM. Alternatively, all or a portion of the state shape files may be copied to a hard drive. **NOTE: If state files are copied to hard disk, make sure the state of Minnesota (mn.*) files are included.**

Approximate sizes of CATS system components are as follows:

ArcView with Spatial Analyst .... 60 MB

ESRI Streetmap (Extension, Highway and Streets Directories only) .... 550 MB

HPAC (Version 3.1 or 3.2) .... 550 MB

ALOHA.. 3 MB

CATS (CATS451 Version, w/o Polydata).. 1350 MB

CATS (CATS451 Version, w/ Polydata) .... 1913 MB

The total installed size of the CATS451 system, as a whole, ranges between approximately 2.513 Gbytes and 3.076 Gbytes, depending on the number of installed options, such as ESRI Streetmap, State Polydata, HPAC, and ALOHA, and whether a world or CONUS installation is chosen. Note that it is possible to install HPAC without much of its data base. If such an installation is performed, the user must depend on the HPAC installation CD for those data. Finally, output and working files generated by CATS hazard applications can be very large. These include the data files and the shape files created for loading into ArcView. Thus, it is recommended that additional working space be available for working directories as follows:

CATS Working Directories..200 megabytes (recommended)

Also CATS requires a large amount of swap or virtual memory space:

CATS Virtual Memory(PC) Space ....200 megabytes (recommended)

Taking into account all of the above requirements, the approximate total hard disk storage requirement for CATS operation on the PC is between 2.9 and 3.4 gigabytes. This is with all options installed, including the Contiguous, Continental United States (CONUS) and World databases provided with CATS, but without and with the polygon population data by state, respectively. It is expected that regional data packages will be made available for installation or CD access to support the CATS system.

2.3 SETUP.

Place the CATS Installation CD ROM in the drive. Use START/Run/Browse or Windows Explorer to select **SETUP.EXE**. From Run choose OK; in Explorer double-click on the file icon, using the left mouse button. A screen will appear as illustrated in Figure 2.

2.3.1 Setup Options.

The user has three options for installing CATS.

- Compact
- Custom
- Typical

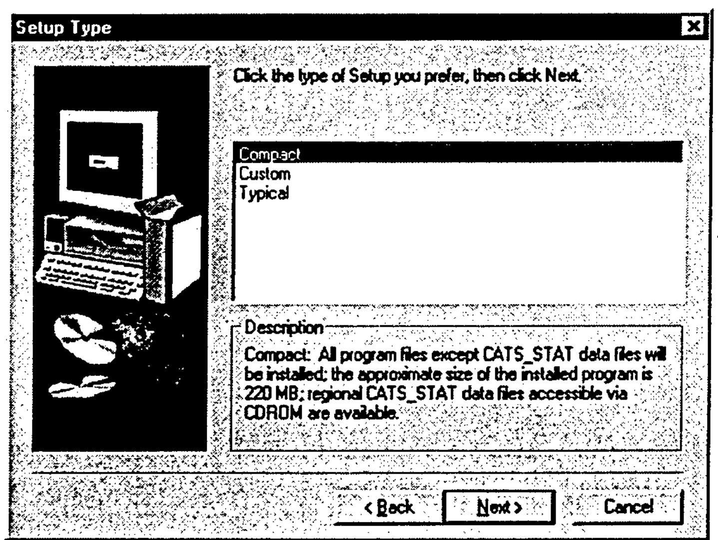


Figure 2. CATS setup options screen.

Compact Installation – This option installs all CATS components, except CATS_STAT, under a single root directory, to be specified by the user, as illustrated in Figure 3. The default drive is C. The default directory name is CATS. This installation option is useful for computers with limited disk space. However, it has the disadvantage that CDROM data access is slow and the drive is not available for other purposes.

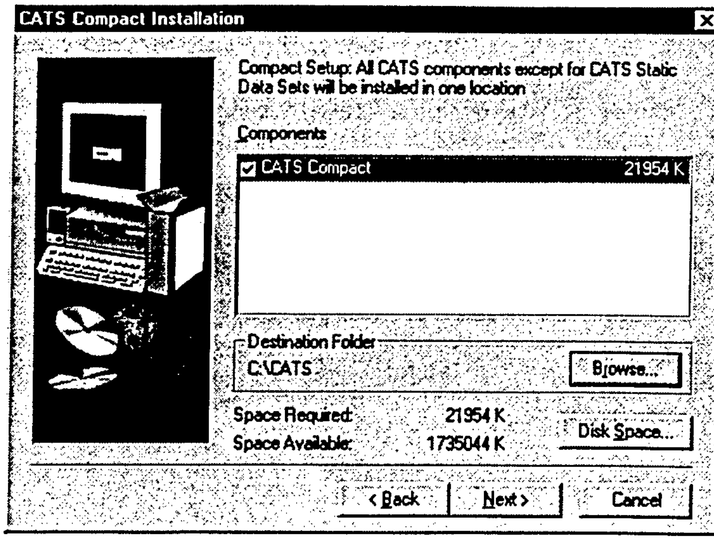


Figure 3. CATS compact installation option.

The user may accept the defaults or choose ***Browser*** to find an existing directory or enter an alternative directory name, as illustrated in Figure 4. If the desired directory name does not exist, the installation program will create it, as illustrated in Figure 5. Disk space required for this installation is indicated, as is the space available on the specified drive, as shown in Figure 6. The user may query available drives for disk space by selecting the ***Disk Space*** button and choosing from available drives.

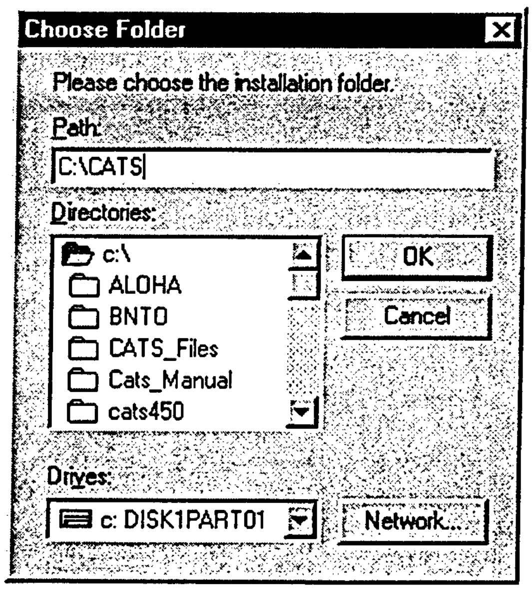


Figure 4. CATS installation folder (directory) browser.

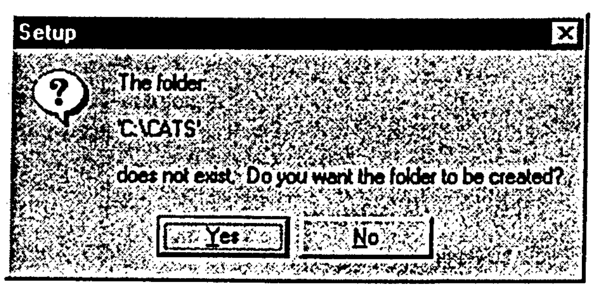


Figure 5. CATS folder creation permission screen.

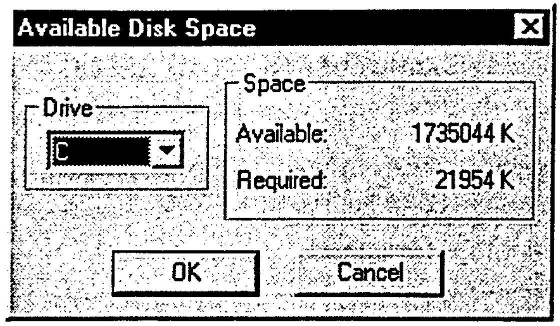


Figure 6. Available disk space query.

Note: In order to run CATS installed using the Compact installation mode, CATS_STAT must be accessible from a CDROM or a network drive. Regional CATS_STAT CDROMS are available on request.

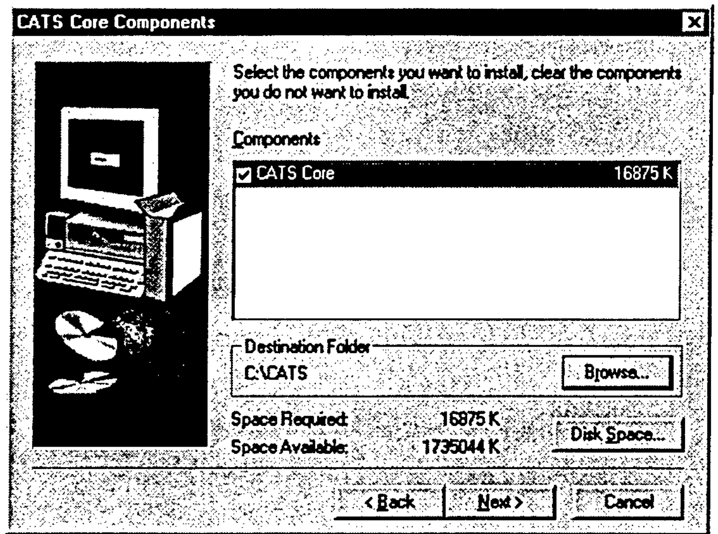


Figure 7. CATS Core components installation instruction screen.

Custom Installation – This option allows the user to assign locations to three individual CATS product components, CATS Core, CATS Real Time Data and CATS_STAT, at installation. CATS Core consists of all files in the CATS root directory, including the CATS application, and the directories TECH_HAZ and NATU_HAZ. The Custom Installation option is particularly useful if the user has access to multiple on-board or network drives. The components are installed in succession from different screens. The installation instruction screen for CATS Core is illustrated in Figure 7.

The installation instruction screen for each component provides the installed size of each component and the space remaining on the default drive, usually the C drive. The user may ***Browse*** to change drives and directories or select ***Disk Space*** to query available drives for sufficient space. Select ***Next*** to proceed with the specification of directories for each of the remaining components. The CATS root directory is that containing the CATS Core components.

Note: ALL COMPONENTS MUST BE INSTALLED or be accessible from CDROM otherwise CATS will not operate.

Note: CATS components may be installed on a network drive.

Note: Core and CATS_RLT components will be installed to the drive indicated, regardless of whether the box is checked.

Note: CATS_RLT must be installed to a drive on which the user has write privilege otherwise the automatic weather retrieval system in CATS will not operate.

The installation instruction screens for the CATS Real Time Data, containing the directory CATS_RLT, and CATS Static Data, containing the directory CATS_STAT, are illustrated in Figures 8 and 9, respectively.

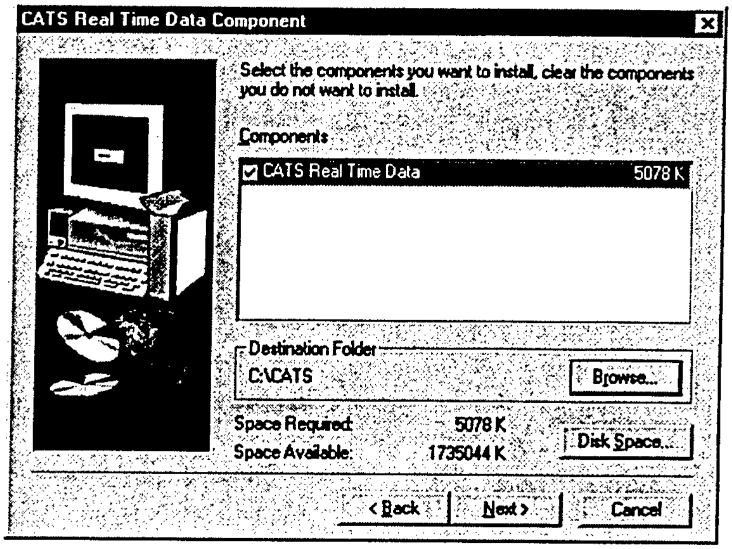


Figure 8. CATS Real Time Data installation instruction screen.

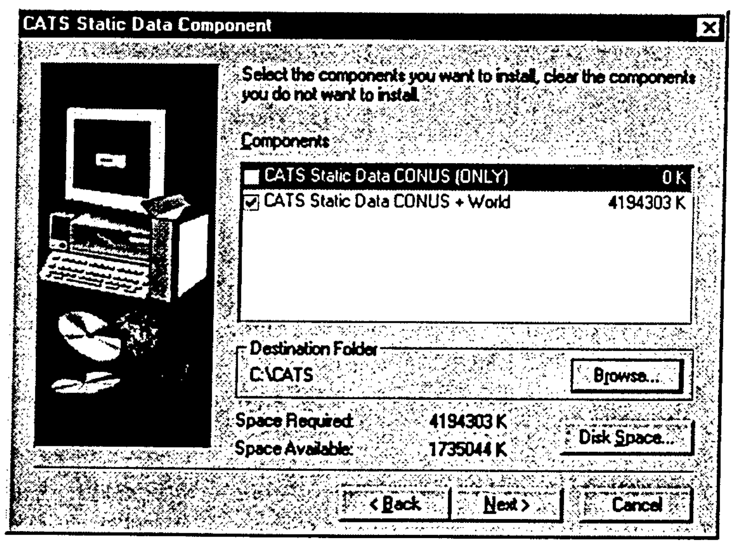


Figure 9. CATS Static Data installation instruction screen.

In the case of CATS Static Data installation, the user has the option of either or neither of the components. If the user checks both, the CONUS + World option will be installed.

Typical – This option causes the entire CATS product, including the CONUS and World data base, approximately 1.35 GB, to be installed under a single root directory, CATS, on a drive specified by the user. As in the case of the other installation options, the user may ***Browse*** to change drives and directories or select ***Disk Space*** to change drives and query them for available space.

Note: CATS components CATS_RLT and CATS_STAT may be installed on a network drive.

Note: CATS_RLT must be installed to a drive on which the user has write privilege or the automatic weather retrieval system in CATS will not operate.

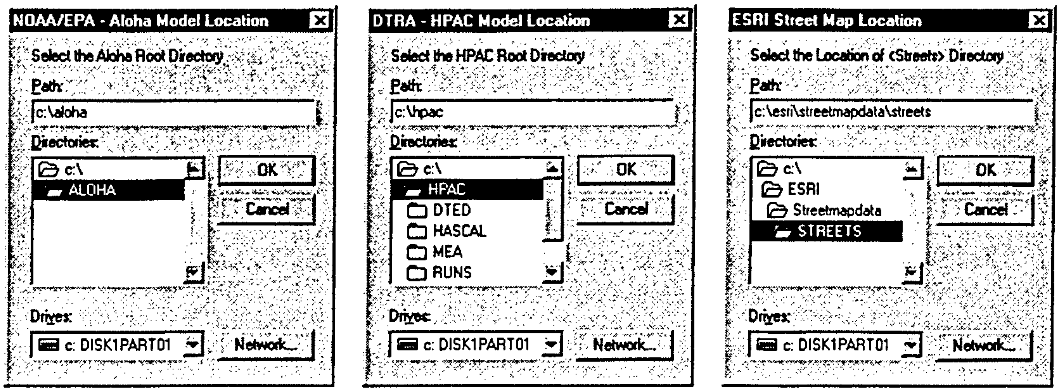


Figure 10. Manual path specification of optional CATS components.

2.3.2 Finishing setup.

After choosing any of the three setup options described above, the user will be prompted to have the Install Shield program automatically search the computer for the locations of the Aloha and HPAC root directories and the location of the ESRI StreetMap, streets subdirectory, as illustrated in Figure 10. The paths to these optional CATS components are recorded in the setup.def file, located in the CATS root directory, and make the programs and data accessible to CATS. If the user answers ***YES*** and one or more of these programs are absent, the installation program will place a text message in setup.def, reminding the user of its purpose.

Note: If the user has both HPAC 3.1 and HPAC 3.2 installed in different directories the query will stop with the first found. Therefore, it is a good idea to check CATS Preferences/CATS System Settings (Section 3.1) to confirm that the correct HPAC home directory is specified.

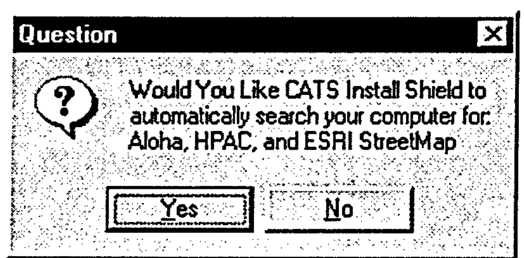


Figure 11. Query to perform search for locations of optional CATS components.

If the user answers ***NO,*** the installation will proceed until all CATS files are loaded. At this point the user will be prompted sequentially to identify manually the locations of the ALOHA, HPAC and ESRI StreetMap STREETS directory, illustrated in Figure 11. The user may navigate to the desired drive/directory combination by double-clicking with the left mouse button the desired drive or directory name shown in the Directories list box. Alternatively, the user may enter the desired path by placing the cursor in the Path edit box and typing the proper name from the keyboard. Based on default load characteristics of these codes and data, the respective entries will appear as:

- [drive]:\ALOHA
- [drive]:\HPAC
- [drive]:\[directory]\STREETS

where drives and directory structure may differ from user to user. If the user *Cancel*'s from each screen without providing a path, the installation program will place a text message in setup.def, reminding the user of its purpose.

After CATS has loaded or, as described above, after the user has dealt with specifying paths to optional components, the user is normally informed that Setup is completed, as illustrated in Figure 12.

All directory locations specified in CATS are relative to an environmental variable named CATSHOME, which is set to the CATS root directory. The CATS setup routine automatically sets that variable name, in the AUTOEXEC.BAT file in Windows 95/98 and in system settings in Windows NT. At completion of the setup routine the user is so informed and queried as to whether to reboot the computer. The user should respond as follows:

If the system is Windows 95/98 the computer must be restarted in order for the environmental variables to be initialized.

If the system is Windows NT it is not necessary to restart the computer.

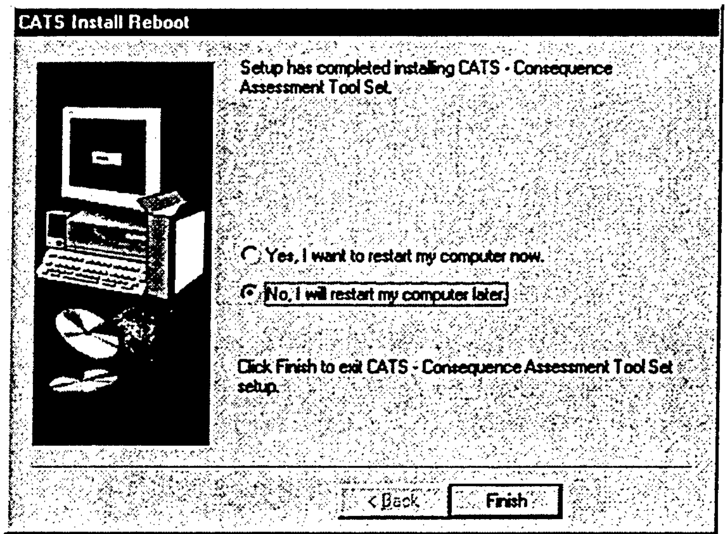


Figure 12. Setup completion and reboot instruction screen.

The environmental variables may also be set or check manually, as described below.

2.3.2.1 <u>Windows 95/98 Environmental Variable.</u>

In the case of Windows 95/98 installations, CATSHOME is set in the AUTOEXEC.BAT file as follows:

set CATSHOME=drive:\[path to cats]
example: set CATSHOME=c:\cats

The user may also perform this function manually, using the SYSEDIT or some other text edit utility. Note: Be sure not to place spaces on either side of the equal sign. After performing the modification, reboot the computer so that the modification will take effect.

Note: Failure to modify AUTOEXEC.BAT as directed in W95 or W98 installations will result in the following error, upon attempting to open CATS###.APR with ArcView: Avenue Error: *CATS.Startup; A Nil object does not recognize request trim.* Upon receiving such an error, exit ArcView without saving the current project, check to make sure the AUTOEXEC.BAT file has been modified as directed above and reboot.

2.3.2.2 <u>Windows NT Setup.</u>

In the case of Windows NT installations, the environmental variable CATSHOME is set automatically. It may also be set or checked manually using the System Control Panel: Select START\SETTINGS\CONTROL_PANEL\SYSTEM. Select the System Environment tab and enter CATSHOME as a Variable and drive:\CATS as the associated value, where drive:\CATS is the location of the CATS root directory. Finally, select SET and APPLY. There is no need to reboot after this process under NT.

Note: Failure to set the variable as directed in WNT installations will result in the following error, upon attempting to open CATS###.APR with ArcView: *Avenue Error: CATS.Startup; A Nil object does not recognize request trim.* Upon receiving such an error, exit ArcView without saving the current project and set the variable as directed above.

2.4 RUNNING CATS.

After installing and setting up CATS and related applications, begin a CATS session on the PC as follows:

Check to make sure that CATS###.APR is a read-only file and carefully maintain it as such.

Double-click on the **CATS icon**  on the desk top. If for any reason that icon is lost, enter Windows Explorer and find the CATS application file. The file is found in the CATS directory and is named CATS###.APR, where the ### stands for the version and build number. Open CATS###.APR with ArcView. Once the link between CATS###.APR and ArcView is established, it may be convenient to create a shortcut for CATS###.APR and to drag that shortcut to the desktop. Alternatively the user may execute CATS by starting an ArcView session and opening CATS###.APR.

CATS opens in the Project Screen mode, as illustrated in Figure 13. From the Project Screen:

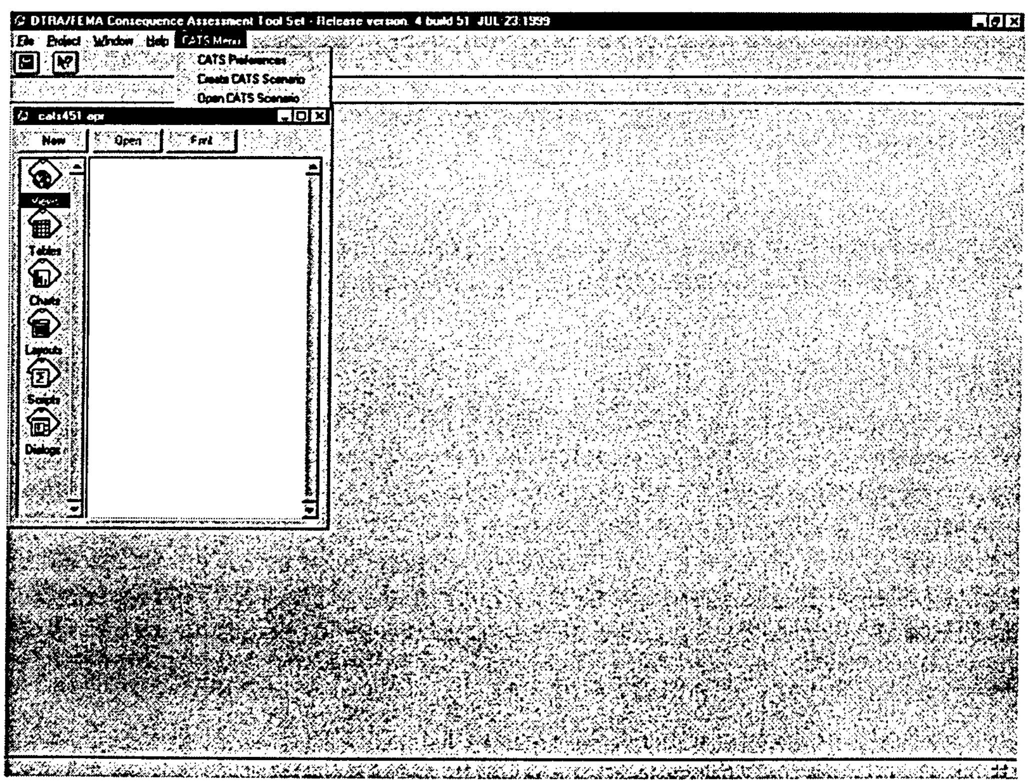


Figure 13. CATS Project screen, with CATS Menu pull-down menu active.

- From **CATS Menu** pull-down menu, Select **CATS Preferences.**
- Scroll to and select **CATS SYSTEM SETTINGS** and click **OK.**
- Set path to **CATS Polygon Population Data by State** if those data have been installed on the hard disk or are to be used directly from the CDROM.
- If computer has active **Internet Access**, change that entry to **TRUE.**
- Review CATS Preferences; Locations of CATS components, such as CATS_RLT and CATS_STAT are recorded at installation and saved in the directory SETUP.DEF, which is located in the CATS root directory. At startup CATS reads that file. If the user changes any of these settings in CATS System Settings, the changes are saved in the CATS.DEF file in the current working directory and are not made as permanent changes to SETUP.DEF.
- After Updating CATS Preferences, select **OK.**

Next, from the Project Screen:

- Under CATS Menu, Select CATS Preferences
- Select **CATS Working** Directory and click **OK**
- Upon execution, CATS###.APR automatically creates a default working directory, **c:\catsruns**. The user is encouraged to specify a new working directory for each CATS analysis session. If the specified directory does not exist CATS will create it. All files generated for display and analysis in CATS are saved in the current working directory.

Finally, from the Project Screen:

- Under CATS Menu, Select Create CATS Scenario.
- For World installations, select **CONUSDEF** or **WORLDDEF** scenario setup files to create CONUS or World scenarios; for CONUS installations, select CONUSDEF to create a scenario. Scenarios consist of base maps and infrastructure data to be loaded into a View.

Note: A complete description of Project Screen operation is provided in Section 3.

CATS scenarios are created in a View screen, as illustrated in Figure 14. All CATS display and analysis takes place in the View screen.

- Create a technological hazard, see Section 5. Create a natural hazard, see Section 6.
- Perform consequence assessment on an existing hazard, see Section 7.
- Perform response resource sustainability analysis on an existing hazard, see Section 8.

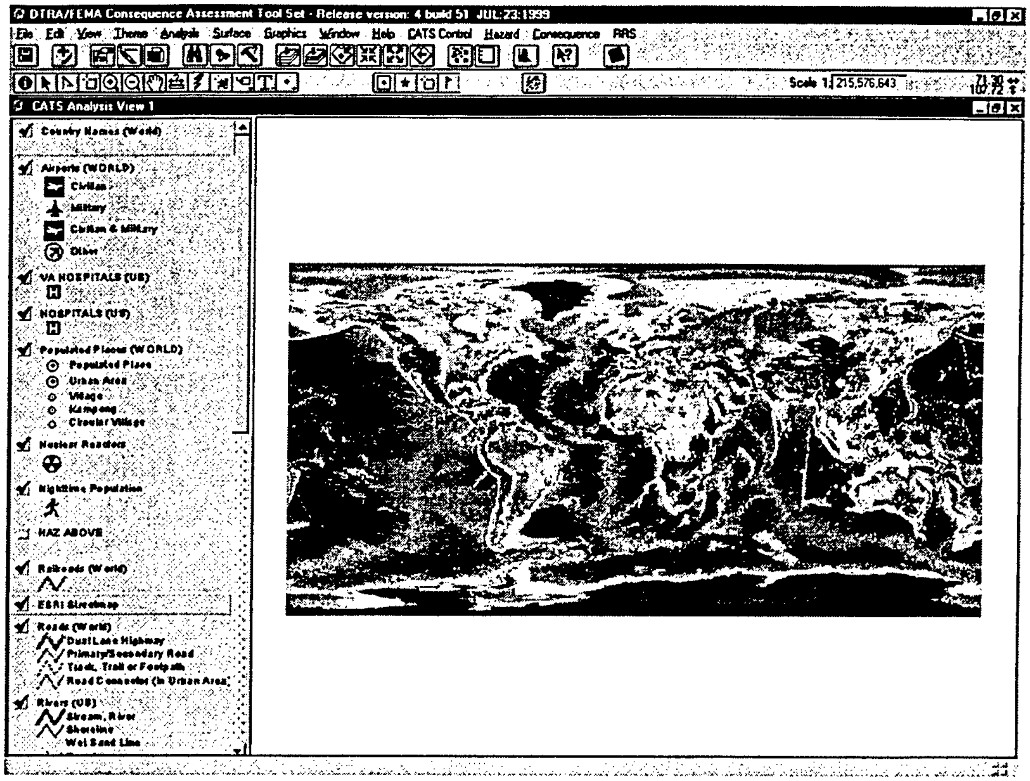


Figure 14. CATS View screen.

Note: A complete description of View Screen operation is provided in Section 4.

Note: If the CATS###.APR file is inadvertently saved to include a View or Table and the files supporting that View or Table are no longer available in their original directories, the user will be prompted to find the missing files. If it is important that the View be reconstructed and the files are known to exist, the user should find each missing file, as instructed. Otherwise, it is usually best to select the *CANCEL ALL* option. This will allow CATS to open without the entire contents of the active View. Next, delete all Views and Tables that may have been saved as part of the session. Finally, save the CATS###.APR application and set its properties to **Read Only.**

Note: CATS###.APR and *.CAT (CATS Scenario) files are not automatically backward compatible from ARCVIEW Version 3.1 to Version 3.0.

- In order to open a *.apr file using Version 3.0, that has been saved under Version 3.1, obtain the Dialog Designer extension for ArcView 3.0. That extension is available free of charge from the ESRI web site. Open ArcView 3.0, select the File command and then the Extension command; check on the Dialog Designer extension. Open the desired *.apr file, turn off (un-check) the Dialog Designer extension and save the *.apr file. Make sure the *.apr file contains no Views or Tables before saving. The *.apr file may now be opened directly into ArcView 3.0.

- In order to open a *.cat file (CATS Scenario) using Version 3.0, that has been saved under Version 3.1, obtain the Dialog Designer extension for ArcView 3.0. That extension is available free of charge from the ESRI web site. Open CATS###.APR under ArcView 3.0, select the File command and then the Extension command; check on the Dialog Designer extension. Open the desired *.cat file (CATS Scenario), return to the Project screen and turn off(un-check) the Dialog Designer extension, return to the View screen and save the CATS Scenario. The *.cat file may now be opened in any CATS session under ArcView 3.0.

SECTION 3

CATS PROJECT SCREEN

At startup of a CATS session the project screen appears as illustrated in Figure 15. It consists of two parts, CATS Project Screen Controls, along the top bar of the screen, and the CATS Project Window, at the top of which is the CATS application file name, CATS###.APR. . The symbol ### represents the CATS edition number. The CATS application file is opened with ArcView and should be maintained as a read-only file.

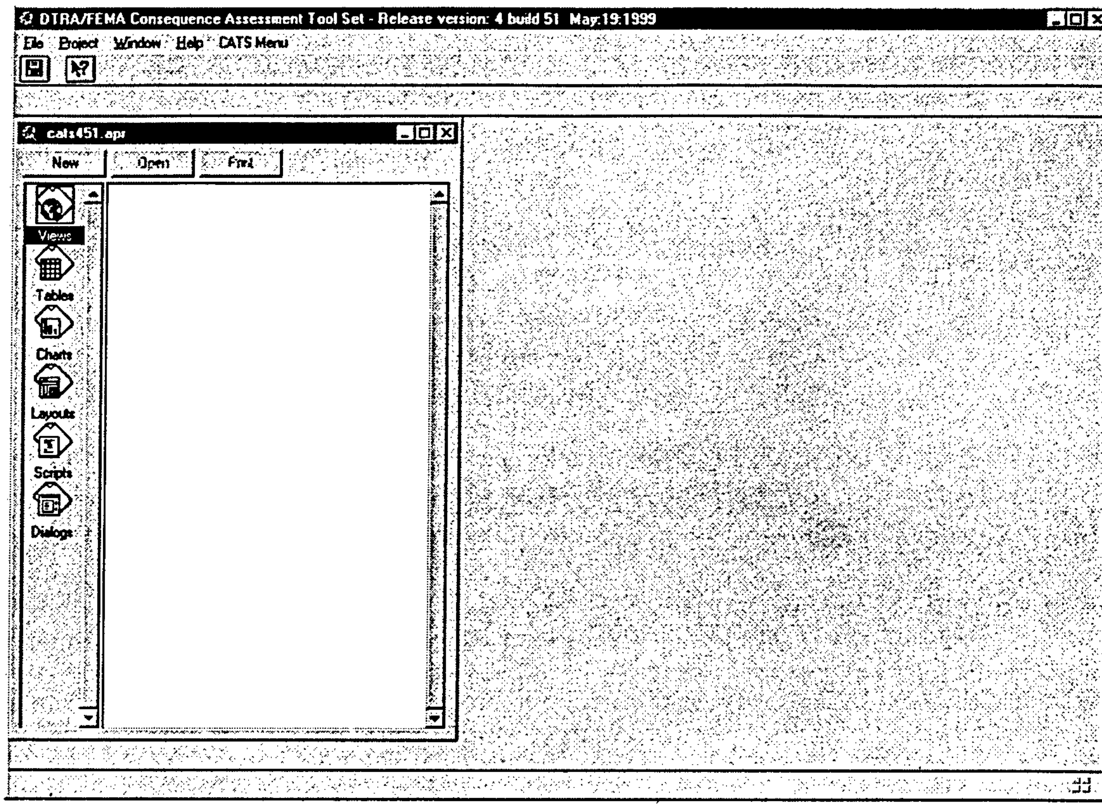


Figure 15. CATS ArcView session project screen upon entry.

After starting the CATS application, the user should select the **CATS Menu** command in the project screen controls. The user should then either, use **CATS Preferences** to enter a new run directory and the locations of important files, use **Create CATS Scenario** to set up and enter a new CATS operating environment, or "View," or use **Open CATS Scenario** to retrieve and enter a View that has been previously created and saved. These processes are described in detail below. CATS Scenarios may be saved, as described in Section 4.1.7.

3.1 CATS PROJECT SCREEN MENUS.

When the Project Window is displayed, the CATS main screen contains a unique set of menu selections located at the top of the window. When selected, these menus reveal a pull-down lists of commands pertaining to the maintenance of Projects and Views. Commands of particular interest to CATS users are described below. Other ArcView commands are described briefly or omitted altogether. The user should consult ArcView documentation for additional information.

3.1.1 CATS Menu.

The primary tools for the CATS user within the Project window are contained in the pull-down menu under the **CATS Menu** command, as illustrated in Figure 16.

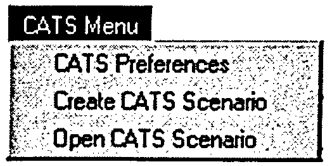


Figure 16. Commands under CATS Menu.

3.1.1.1 CATS Preferences.

Allow the user to view or edit directory locations for important CATS resources. The CATS Preference options are illustrated in Figure 17.

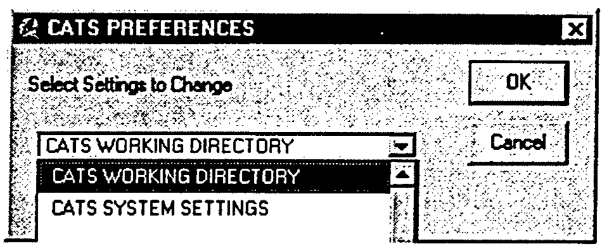


Figure 17. CATS Preferences options.

CATS WORKING DIRECTORY is the location of all files associated with a specific CATS Scenario or View. This directory contains all files specific to that View including the *.CAT Object database (Scenario) file, all shape files specific to that view, and all working files resulting from hazard calculations, except those from HPAC, which are stored under HPAC\RUNS. If the working directory is changed in the box illustrated in Figure 18, all files will subsequently be saved to the new Working Directory. However, note that CATS always opens in the directory c:\catsruns (drive designation applicable to the PC only) and will make that directory if it is not found. Likewise, CATS will create a newly-defined working directory if one by that name does not already exist. It is a good idea to create a new working directory for each new project; this provides an easy means of archiving complete data sets associated with saved scenarios (see Section 4.1.7).

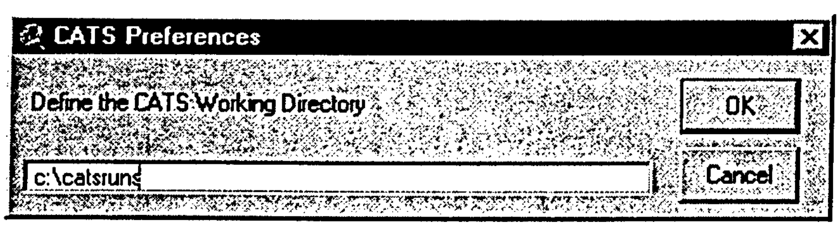


Figure 18. CATS Working Directory specification.

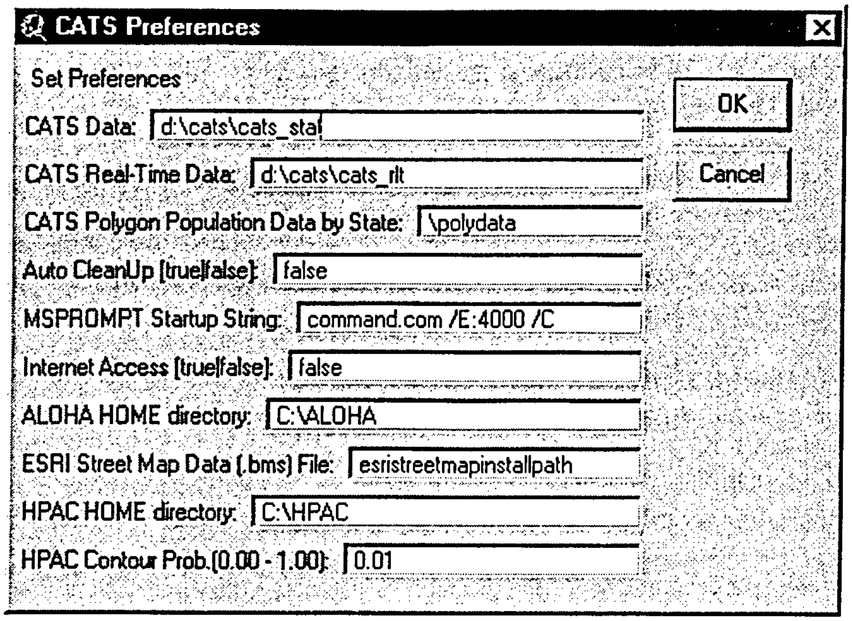


Figure 19. CATS System Settings specifications.

CATS SYSTEM SETTINGS, illustrated in Figure 19, allow the user to do the following:

- Specify the location of the CATS static data library, normally [drive:\]CATS\CATS_STAT. These data include maps, census and other data that are loaded automatically when a CATS scenario is created and used for various types of consequence analyses. These data amount to approximately 541 MB. If the location where CATS is installed does not have sufficient space to hold that much data, the data may be installed at a different location or even left on the installation CD ROM, so long as their address is properly entered in CATS Preferences/CATS Data (see Figure 19).

- Specify the location for storing Real-Time data such as NWS hurricane warnings, NWS meteorological surface observations, and NEIC earthquake notification messages. The default for this field, [drive:\]CATS\CATS_RLT, is adequate if CATS has been installed using either: 1. The Minimal HD Installation or 2. Full HD Installation instructions (as described in the CATS Installation Instructions). However, this option is valuable if Real-Time data become too large for the drive on which CATS resides or are more conveniently located elsewhere.

- Specify the location of the CATS Polygon Population Data files for CONUS by state. These are the area-distributed population data and are very large (563 MB). They are provided on a separate CDROM. They may be loaded into a folder or directory on the user's computer (typically cats_stat\pop\poly), if sufficient resources are available, or accessed directly on the CDROM, so long as their location is properly entered in CATS Preferences/CATS Polygon Population Data (Figure 19). For example, such locations might be entered as:

  f:\polydata .... CDROM Location
  or d:\cats\cats_stat\Pop\poly .... Hard Disk Location

- Specify whether or not to automatically remove working files created in the working directory. Specify "true" if Auto Cleanup is preferred. Specify "false" to turn off Auto Cleanup. Note: Auto Cleanup is not operational in this release of CATS.

- Specify the MS Windows Command Interpreter instruction to execute external programs. **This field should not be altered** unless instructed to do so by technical support.

- Specify, true or false, indicating whether the machine on which CATS has been installed has current Internet access. The net connection should be active in order to specify true.

- Specify the location the home directory of ALOHA, a resource for calculating toxic industrial material (TIM) hazards, which is installed independently of CATS.

- Specify the location of ESRI Streetmap setup (USA_st.bms) files; such as [drive] :\[directory]\streets\usa_st.bms.

- Specify the location the home directory of HPAC, either version 3.1 or 3.2, a resource for calculating NBC hazards, which is installed independently of CATS.

- Specify the probability (expressed as a fraction; 0.01=1%, 0.99=99%, etc.) associated with the non-conditional Gaussian hazard probability distribution used in the display of HPAC radiation dose criteria and (Rapid Hazard Analysis mode only) HPAC chemical and biological dosage themes. The size of the footprint is inversely proportional to the probability value, i.e., the lower the probability value, the larger the distance to which it may extend.

Note: The default working directory for CATS is C:\CATSRUNS; upon starting a CATS session CATS SYSTEM SETTINGS will always correspond to the settings recorded in that directory in CATS.DEF. If no C:\CATSRUNS directory or CATS.DEF file exists, settings will revert to defaults stored in SETUP.DEF, a file created at time of installation and located in the CATS root directory. The defaults will be recorded in a new CATS.DEF in C:\CATSRUNS and may be modified using CATS SYSTEM SETTINGS.

Note: If the user changes the working directory to another new or existing working directory, no change in CATS SYSTEM SETTINGS will take place if no CATS.DEF file is present. Further, if no changes in the settings are made after entering a new run directory, no CATS.DEF file will be created in the new run directory. However, if settings changes are made, a new CATS.DEF will be created in the current run directory, and settings will be reset to correspond to those recorded in that CATS.DEF each time the user enters that directory.

Note: CATS SYSTEM SETTINGS are recorded in the CATS.DEF file in the current run directory. CATS452 CATS.DEF files are not compatible with those of previous versions. CATS452 is designed to delete the CATS.DEF file in any directory created for a previous version of CATS, including "CATSRUNS" upon entry.

3.1.1.2 Create CATS Scenario.

This command creates a View containing all basic data required for display and analysis of the hazards to be created later as part of the scenario. The user is prompted to select a view containing either CONUS or the entire world, as illustrated in Figure 20. An illustration of a basic CATS CONUS scenario may be found along with a complete description of its use, including saving a scenario, in Section 4 of this manual (Figure 21).

A View window consists of a display area that may contain maps and other data. To the left of the display area is a Table of Contents for the View. Along with maps, the View is typically made up of layers of geographic information for a particular area or place. Each layer, called a Theme, is a collection of geographic features, such as rivers, and cities. All Themes in a View are listed in the Table of Contents. A Theme listed at the top of the Table of Contents is drawn on top of those listed below it. The Table of Contents lists the name of the Theme, the symbol or color used to draw the Theme, and a check box indicating whether or not the Theme is currently being displayed. Note that if there are no Themes selected, the display window will be blank. Only when a Theme is selected will the map, along with that Theme, be displayed.

The default name of a new scenario is CATS Analysis View #, where # is an index number. The scenario may be renamed, as described below. If a scenario is renamed, the default numbering sequence will be reset to omit that which has been renamed, i.e., if "CATS Analysis View 3" is the last new scenario created, and it is renamed "Sarin Analysis" a new scenario would be added subsequently as CATS Analysis View 3.

3.1.1.3 Open CATS Scenario.

Retrieves a CATS Scenario from the current directory, making it the active view.

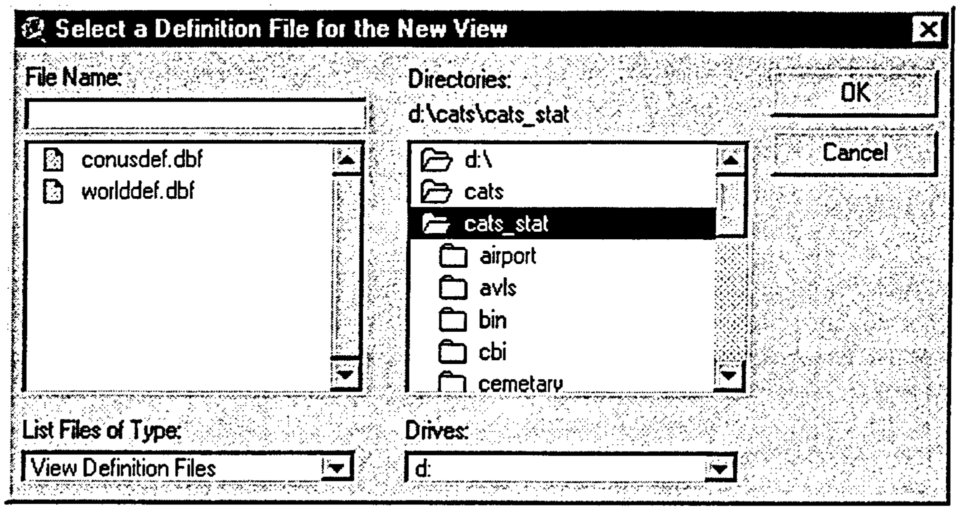


Figure 20. CATS Scenario Definition, CONUS or World.

3.1.2 File.

It is normal to set up a shortcut that calls the CATS###.APR to be loaded into ArcView, and to drag the shortcut icon onto the desktop, as the initial acts of starting the CATS application. However, if the user first opens an ArcView session and then wishes to start CATS, use ***Open Project*** or ***Close Project*** to begin or end a session with an existing project (*.apr) file. The command ***Save Project*** should not be used to update the CATS session that is currently open, and the CATS###.APR file should be set and maintained as read-only. The user may select the command ***Save Project As...*** to back up CATS###.APR under another name, if desired. The ***Exit*** command ends the CATS session. ArcView gives the user an opportunity to save current work after selecting ***Exit.*** However, as noted previously, the CATS###.APR should not be saved.

3.1.3 Project.

Use the commands in the **Project** drop-down menu to modify project properties.

The ***Properties*** command is used to obtain information about the project such as the user name of the creator of the project and its initial creation date. It also allows the user to enter comments pertinent to the current state of the project. Use the ***Customize*** command to change scripts associated with the project (NOT AVAILABLE TO CATS USERS).

Use the ***Rename 'View Name'*** command to customize the name of individual Views during a CATS session. The default View names are Cats Analyis View l, Cats Analysis View 2,... CATS Analysis View N, which are not very informative. Highlight the desired View, choose Rename [View Name] and enter the desired name. This is not a file name and may contain empty spaces. Note that the new name applies only during the current session, unless the user saves the Scenario (View), as described in section 4 of this manual.

Use the ***Delete 'View Name'*** command to delete individual Views from the Project Window. Highlight the desired View and choose *Delete* [View Name]. The user is given a second chance to retain the View. Note that this command does NOT delete a file. However, if a View is deleted without having been saved as a CATS Scenario (*.cat) odb file, as described in section 4, it is lost.

The ***Add Table*** command is used to create a separate window containing tabular data. These data may be in the form of (*.txt) files, data from Theme objects on file (*.dbf files), or INFO files (see ArcView documentation for description of INFO files).

Use the ***Import*** command to retrieve Views that have been saved as *.CAT files. It also allows the user to append the ENTIRE CONTENTS of a another ArcView project (*.apr file) to the current project.

Use the ***Set Connect*** command to establish a connection to a database server and form an SQL query to retrieve records from the database (see ArcView documentation for detailed instructions).

3.2 PROJECT WINDOW.

At the top of the Project window is a title bar containing the name of the edition of CATS. The window provides access to all objects that have been created or recalled in CATS. It contains lists of all the views, tables, charts, layouts, and scripts that have already been loaded into the CATS session. These objects are active and available for immediate use in the CATS ArcView application.

A list of active Views, also referred to as CATS Scenarios, may be obtained by selecting the View icon in the Project Window. These Scenarios contain interactive data that let the user display, explore, query, and analyze geographic information in ArcView. For information on ArcView options and operation beyond what is contained in this manual, please refer to the ArcView documentation or the on-line help.

Note that CATS scripts are not accessible by the user.

3.2.1 New (Views).

The *New* command button creates a new, blank View window. This View window may be customized by adding themes as desired by the user. It may also be saved as a CATS Scenario. An alternative to the New (Views) command in the Project window is the Create CATS Scenario command, located in the CATS Menu at the top of the Project screen. Use the Create CATS Scenario command to create a new View, fully populated with background map data, as described above.

3.2.2 Open (Views).

Use the ***Open*** command button to open an existing View from the list provided in the Project Window. The View can also be opened by double-clicking with the cursor on the desired View name. The *Open* command brings to the foreground the selected View, hiding the Project Window and changing the configuration of the CATS main screen to include controls for creating and modifying objects and images in the current View. These controls and their functions are described in section 4 of this document.

3.2.3 Print (Views).

The ***Print*** command enables the user to print a list of Views. On the PC, print directly to any available printer.

SECTION 4

CATS VIEW SCREEN

A View Screen appears when a View is created, using the Create CATS Scenario command, recalled, using the Open CATS Scenario command, under CATS Menu in the Project screen or CATS Control in the View Screen, selected from the View list in the Project Window or restored from icon form. An example View Screen is shown in Figure 21. The View Screen includes four elements, the CATS controls located in the upper-most section, the CATS-customized ArcView tool bars located in the second and third section, the Table of Contents on the left, and, finally, the View Window.

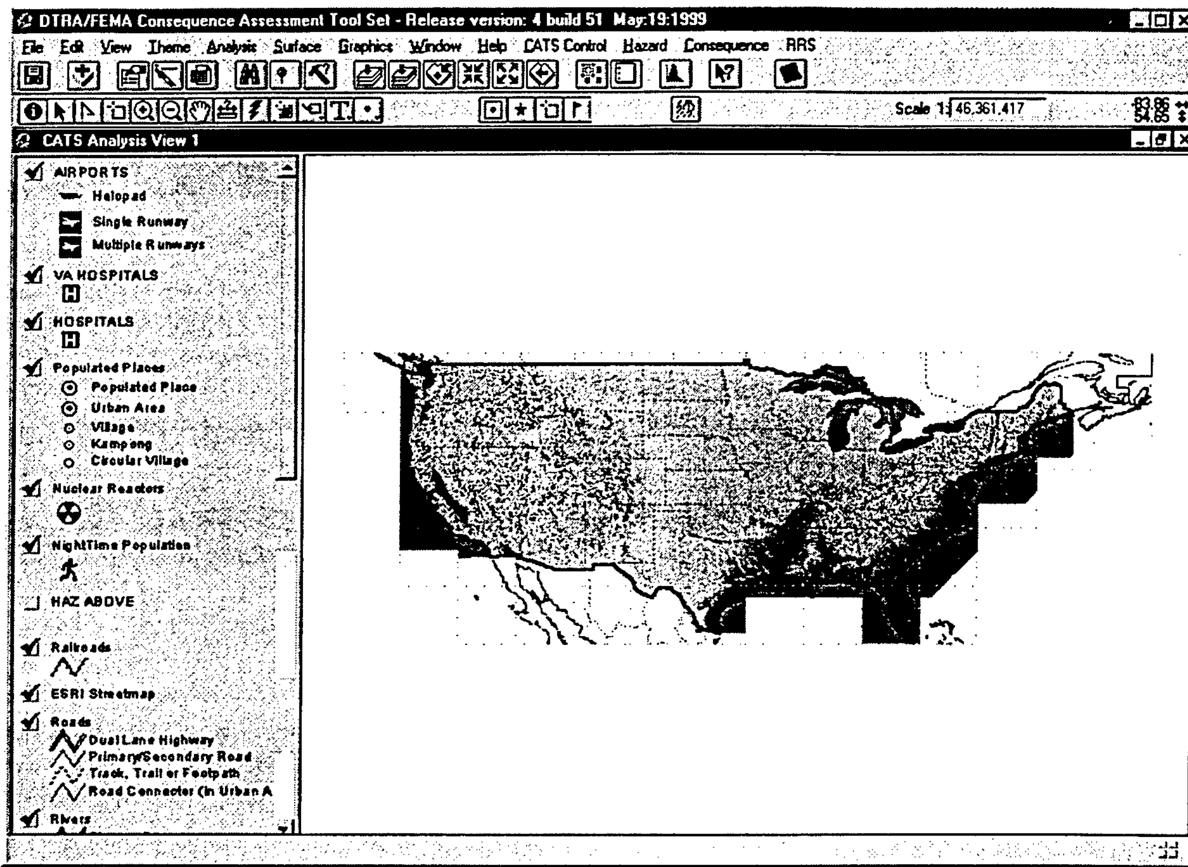


Figure 21. Example View Screen.

4.1 VIEW SCREEN CONTROLS.

Upon activation of a View, the menus, buttons and tools at the top of screen change from those associated with a CATS Project Screen to those associated with a CATS View Screen. These controls expand the capabilities of CATS beyond those of a normal ArcView session.

The View Screen controls facilitate the user in creating hazard and casualty probability distributions, as well as in adding or modifying objects in the active View or in performing other analysis activities. The user may return to the Project Screen controls by minimizing the current View or bringing the Project Window to the foreground. Below are descriptions of the controls specific to CATS, as well as those ArcView controls which are relevant to CATS operation. The user should consult ArcView documentation for additional information on View screen controls.

4.1.1 File.

The commands under **File** enable the user to manipulate the various projects created. The ***Close*** command closes the component of the current CATS session that is currently active, such as the current View. The ***Close All*** command closes all open components whether active, background or minimized. Use of the CATS View Screen

Close or Close All commands will return the user to the Project screen configuration described in Section 3 of this report. Note that the Close command does not erase the file containing the view or other active component from the current CATS session; it may be re-displayed by returning to the Project Screen, selecting it from the appropriate category and opening it.

The ***Save Project*** command does NOT work in CATS because the CATS##.APR cannot save the project under its current name. Rather, individual CATS Scenarios (Views) are saved as Object DataBase files with the extension *.cat. The files are loaded from the Project screen to create the content of a CATS session.

Use the ***Print*** command to print the contents of a View window. On a PC the user may print directly to any available printer. However, the ArcView print utility has not been very satisfactory in reproducing details of the View as displayed on the monitor. Therefore, it is recommended that the user Export the contents of the View (or Layout) as a graphics file and print them in other software, such as Word or Powerpoint.

Use the ***Export*** command to export the contents of a View window to a graphics file. The Table of Contents associated with the View is not exported. Select the export format of interest using the List Files of Type menu. This also will list all existing files of that type in the current working directory. In the Export dialogue box, type the file name under which the View is to be saved or select the name of an existing file to be replaced. JPEG, Windows Bitmap or CGM Binary formats are recommended if the export is intended for use with a PC application.

The ***Exit*** command allows the user to exit CATS and its ArcView session entirely. The user is given a second chance to abort the exit process and return to the current CATS session to save individual Views as CATS Scenario (*.cat) files. The user SHOULD NOT attempt to save the project.

4.1.2 Edit.

The commands under Edit provide the user control over existing themes and graphics displayed in the current View. Themes in the Table of Contents may be cut, copied or deleted. First, highlight the desired Theme by clicking the cursor in the Theme box in the Table of Contents. Highlight multiple Themes by holding down the Shift key while clicking the cursor. ***Cut Themes*** removes the highlighted Theme(s) from the Table of Contents and saves it to the clipboard for pasting in another View. ***Copy Themes*** saves the highlighted Theme(s) to the clipboard for pasting elsewhere or for duplicating a Theme in the same View.

Delete Themes removes the highlighted Theme(s) from the Table of Contents with no recourse to pasting elsewhere.

Graphics created in the current View may be cut, copied, deleted or merged. First, highlight the desired graphic by clicking the cursor over the graphic location. Highlight multiple graphics by holding down the Shift key while clicking the cursor. ***Cut Graphics*** removes the highlighted graphic(s) and saves it to the clipboard for pasting in another View. ***Copy Graphics*** saves the highlighted graphics(s) to the clipboard for pasting elsewhere or for duplicating a graphic in the same View. ***Delete Graphics*** removes the highlighted graphic(s) without allowing it to be pasted elsewhere. See ArcView documentation or Help facility for an explanation of the ***Merge Graphics*** command.

The ***Paste*** command allows the user to paste a previously cut or copied Theme into the Table of Contents of the active View. Paste also allows the user to paste a previously cut or copied graphic or graphics into the active View.

The *Select All Graphics* command highlights all graphics in the active View.

4.1.3 View.

The commands under **View** enable the user control over the active View, its properties, constituent themes, and magnification level.

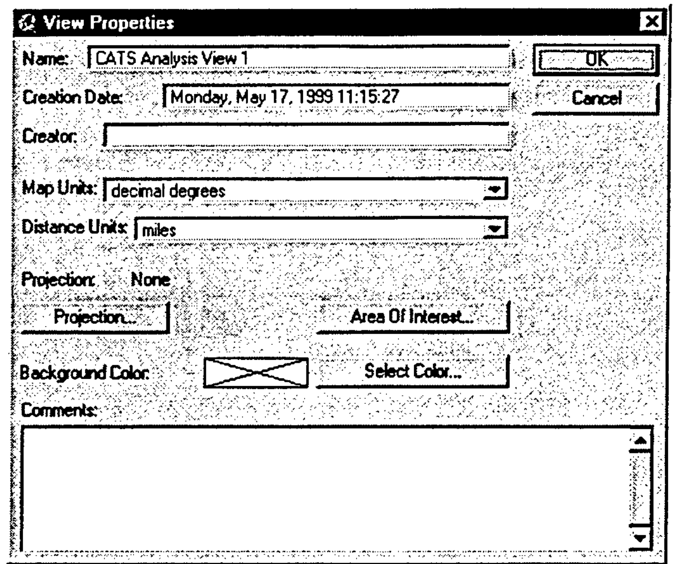


Figure 22. View properties dialog box.

The ***Properties*** command produces a dialogue box, illustrated in Figure 22, which allows the user to specify certain important properties of the View. The Name of the View may be changed, as may the name of the Creator of the View. The Creation Date is entered automatically and may not be changed. The Map Units are the units in which the coordinates of the spatial data represented in the active View are stored. ArcView uses the map units setting to determine the correct scale of the active View.

The default Map Unit is Decimal Degrees. If the Map Units are not set correctly, the scale ArcView displays for the View may be incorrect. Digital Chart of the World (DCW), ARCUSA and ARCWORLD are typical examples of spatial data used in CATS; these are stored with units of Decimal Degrees. Consult ArcView Help for ways of determining spatial data Map Units.

When Map Units are specified, the user should also specify the desired Distance Units. These are used in map scale displays and in distance measurements. Default Distance units are miles. Distance units of kilometers or miles are recommended for most Views. Specifying Map Units also allows the user to specify a Projection in which to display the View. Unless the user is very familiar with the parameters associated with specifying a map project, it is suggested that the choice be limited to Category: Projections of the World, Type: Geographic.

The Properties dialog box also has an Area of Interest command button. Activate this command and select a Theme name to determine its geographic limits. Finally, the user may wish to record Comments pertaining to the active View in the text box provided.

Themes are listed in the Table of Contents and are derived from image files (typically, gee-referenced scanned images, such as maps or photographs) or shape files (geographic objects bearing additional information, such as a highway right-of-way and its associated vehicle through put capacity). These may be added to the active View as desired, using the *Add Theme* command.

Selecting *Add Theme* reveals a file service box set up to call to lists of Feature Data Source (shape) or Image Data Source type files. As illustrated in Figure 23, the CATS directory tree is divided below cats into cats_rlt, cats_stat, natu_haz, and tech_haz. Cats_rlt is where real time messages for hurricane and earthquake are collected and stored. Cats_stat is where static data required by all models are stored (background maps, demographic and infrastructure data). Natu_haz is where the natural hazard prediction models and data needed to run those models are stored. Tech_haz is where the technological hazard prediction models and data needed to run those models are stored.

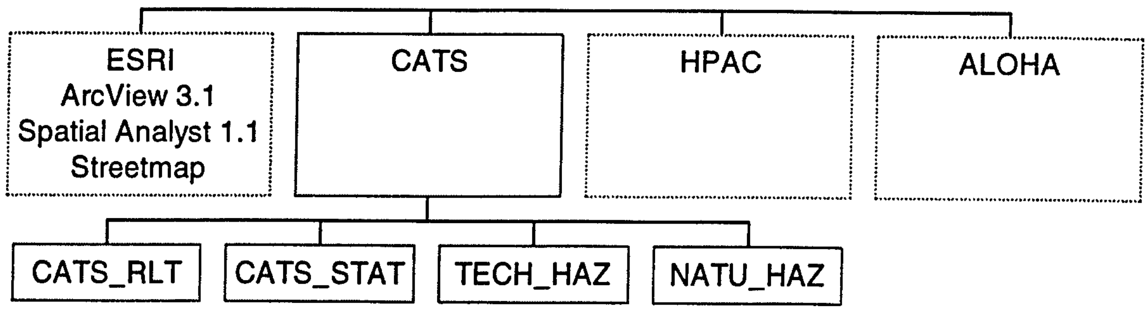


Figure 23. CATS directory structure.

For an explanation of *New Theme,* see the ArcView documentation or Help facility. The *Themes On* and *Themes Off* commands turn all Themes in the Table of Contents of the current View either on or off, respectively. The *Layout* command may be used to create an annotated graphic display based on the current View. See the ArcView documentation or Help facility for an explanation.

The user is provided with a number of convenient, predefined commands that control the magnification in the current View. *Full Extent* zooms to the limits of all Themes in the Table of Contents. NOTE: Be careful, it can take a very long time to draw all the features of all the Themes currently loaded in the Table of Contents. *Zoom In* and *Zoom Out* take a single step in magnification referenced from the center of the current View. *Zoom to Themes* zooms to the limits of all active (highlighted) Themes. *Zoom to Selected...* zooms to the limits of selected features in active Themes.

4.1.4 Theme.

Each entry in the View Table of Contents is the legend of a Theme. The Theme drop-down menu provides the user with the ability to manipulate the legends in the Table of Contents. The ArcView on-line Help and documentation provide detailed discussion on these features. Commands of special interest to the CATS user are described in the following paragraphs.

Edit Legend - Highlight a legend entry in the View Table of Contents and select this command to edit the legend format. The legend editor for a selected entry may also be accessed by double clicking on the entry itself.

An example of a legend editor screen is provided in Figure 24. This example shows the appearance of the editor for a Graduated Color Legend Type. This type of legend is used with hazard and casualty probability Themes. Such Themes are created from shape files. A shape file may be the source for several Themes. The selection of a particular Theme from a shape file is performed using the Classification Field, which lists the thematic content of the file.

The *Classify* button allows the user to stipulate the number of value intervals used in the legend and number format. The symbols may be selected from defaults using the Color Ramps menu or they may be edited individually using the menu obtained by double clicking on a symbol. The Value specifies the

range of numerical values from the underlying data set associated with a symbol. The Label specifies the text associated with the symbol in the legend.

Once created, a legend may be saved as a *.avl file for future use on similar Themes by using the ***Save*** command and recalled using the ***Load*** command. The library of *.avl files used when hazard Themes are loaded into a View are stored in the avl sub-directories. These are located below each of the corresponding model directories.

After editing a legend entry, the user may elect to undo the changes made. If the edited legend is satisfactory, the user must ***Apply*** the legend format and then manually close the legend editor and associated edit windows.

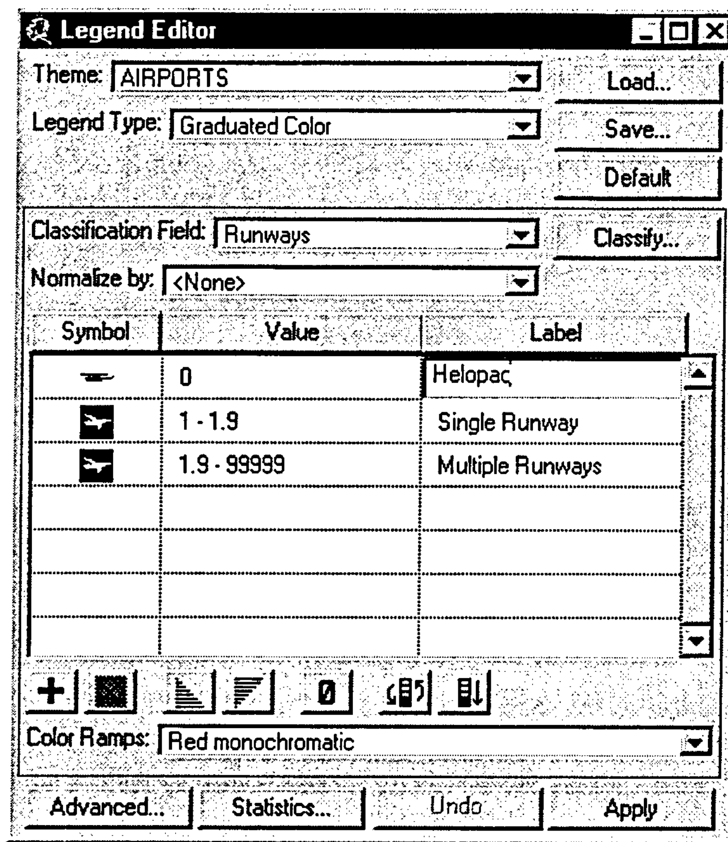


Figure 24. Legend editor.

Hide/Show Legend - This command allows the user to hide or show a highlighted legend as it appears in the Table of Contents. When hidden, only the title line of the legend entry appears. When shown, the entire legend entry is visible. This command is handy for use with Views containing a large number of legend entries.

Clear Selected Features - A user may use ArcView utilities to create a polygon graphic and to use that graphic to select a subset of features of a Theme that lie within the area of the polygon. This process is referred to as "Roping In." The Clear Selected Features command allows the user to cancel the selection.

4.1.5 Analysis.

The Analysis drop-down menu and all of its submenus are the interface to the Spatial Analyst Extension for ArcView. This extension to ArcView allows the user to analyze spatial relationships among his data. The Spatial

Analyst can be used to model raster data in addition to the vector data ArcView already supports. The ArcView Spatial Analyst is provided with its own documentation. It contains tutorials and sample problems. Chapter 8 of the ArcView documentation provides descriptions of the functions found in the Analysis drop-down menu of CATS.

4.1.6 Graphics.

Graphics created with ArcView in CATS may be edited using the Graphics commands. The ***Properties*** command allows the user to modify lines, fills and fonts. The ***Size and Position*** command allows the user to precisely locate a graphic. This is particularly useful when operating in map coordinates. The remaining commands operate in a similar fashion to those found in presentation software for a PC. For further assistance in using Graphics commands, consult the ArcView Help Utility.

4.1.7 CATS Control.

CATS Control provides commands, as shown in Figure 25, for controlling the contents of the CATS session including: the disposition of scenarios, specification of the CATS operating environment, specification of the frame of reference for creation of the Response Requirements Source Code (RRSC), and, finally, a marker for hazard entry into the View Table of Contents.

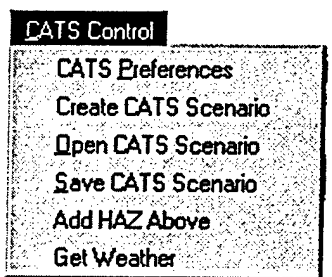


Figure 25. CATS Control commands.

Selecting ***CATS Preferences*** allows the user to change the location of directories pertinent to CATS operation. These include the working directory, where model results are stored, the HPAC directory and the main data directory. CATS Preferences options are discussed in detail in Section 3.2 of this manual.

The ***Create CATS Scenario*** selection under the Cats **Control** pull-down menu will open a new CATS Scenario and load all default background data. This is the same type of customized View that may be created via the Create CATS Scenario command in the Project pull-down menu item from the Project Screen controls. The New CATS View contains numerous Themes considered to be the most essential for assessing disaster consequence.

The ***Open CATS Scenario*** command recalls an existing scenario that has been saved to disk. The CATS scenario files use the extension *.cat. Opening an existing CATS scenario automatically creates a new View.

The ***Save CATS Scenario*** command saves the contents and format of the active View scenario in the current directory, under its current name. The CATS scenario is saved as an Object Data Base (*.cat) odb file. This may be recalled for later display and further analysis.

The ***Add HAZ Above*** menu item places an index, labeled *HAZ Above* in the Table of Contents of the current view. All hazard themes are loaded above this index. The HAZ Above index is automatically loaded when a new CATS View/Scenario is created. Its default location is above line features and below point features. However, the user may move HAZ Above to any position desired.

The *Get Weather* command allows the user to obtain current weather conditions from reporting stations within half a degree of a specified location. Choose the location using the Hazard Origin tool and then select Get Weather to create and save meteorological input for use in CHAS (*.met, *.ter, meteorological and terrain files) and HPAC (*.obs, surface observation files). These files are named for the specified location, i.e., AYYBXXXN.*; where A is either N or S (for North or South Latitude) B is either E or W (for East or West Longitude), YY and XXX are degrees latitude and longitude, respectively, and N is an index to allow multiple files to be saved at the same location. Note that access to Get Met functionality is also provided in the sequence of generating hazards using CHAS (biological and chemical), D2PC and NAERG.

4.1.8 Hazard.

The commands under **Hazard** enable the user to calculate hazard and casualty probability distributions using a variety of codes operating under a common graphic user interface. They also provide for the importation of hazard distributions calculated by codes operating outside the CATS system. In addition, the commands under Hazard provide the means of loading calculated hazard and casualty probability into the geographic information system as objects for display and analysis.

The following sections provide a brief description of each model. Section 5 contains detailed descriptions of all of the technological hazard models contained in CATS and Section 6 contains descriptions of the Natural Hazard models.

4.1.8.1 Rapid Hazard Analysis.

Select the Rapid Hazard Analysis tool to predict hazards for five types of technological hazards, using greatly simplified input and automatic weather acquisition (with internet access). Section 5.1 of this report describes the use of this hazard option.

4.1.8.2 Run Hazard Area.

Allows a hazard area of arbitrary shape and size to be loaded into the active View, based on graphic objects created by the user. Section 5.2 describes the creation of a user-specified hazard area.

4.1.8.3 Run High Explosive

The High Explosive model will estimate the collateral damage as a result of a large explosion. The model predicts the damage based on the equivalent amount of TNT combusted. Section 5.3 of this report describes the input and output of the high explosive model in CATS.

4.1.8.4 Run NAERG.

The *Run NAERC* selection under the Hazard drop-down menu will run the North American Emergency Response Guide (NAERG) model for prescribing initial hazard zones associated with the release of TIMs. Section 5.4 contains a description on how to operate this model under CATS.

4.1.8.5 Run D2PC (and ATP-45).

D2PC is a chemical dispersion code developed by the Army for use in the Federal Emergency Management System (FEMIS) to calculate hazards associated with accidental release of chemical agents from arsenals, production facilities, or other types of storage. As implemented in CATS, D2PC has a capability to calculate hazards from explosions or spills involving accidental release of military agents and toxic industrial materials (TIMs). Section 5.6 contains a description on how to operate the D2PC model under CATS.

Execution of a D2PC calculation also executes the Allied Technical Protocol 45 (ATP-45) prescription for an initial hazard zone (fan) associated the event described in the D2PC input. Choice of TIMs as the event source causes an NAERG fan to be generated, as described below. Section 5.5 describes the ATP-45 model.

4.1.8.6 Run ALOHA.

ALOHA is released by the Environmental Protection Agency, National Oceanographic and Atmospheric Administration and the National Safety Council. It is designed for use in response to chemical accidents. As such, it can predict rates at which chemical vapors escape into the atmosphere from broken gas pipes, leaking tanks and evaporating puddles. Finally, it predicts how the resulting hazardous gas cloud may disperse in the atmosphere. The ALOHA data base contains data on approximately 900 common hazardous chemicals. The operation of ALOHA is described in Section 5.7 of this manual.

4.1.8.7 Run CHAS Nuclear, Biological. Chemical Hazards.

The Comprehensive Hazard Assessment System (CHAS) facilitates the operation of codes for the computation of nuclear, biological, and chemical hazards and associated casualty probabilities. CHAS provides the means of describing a hazard-producing event by selecting from a few, pre-defined options and providing simple descriptions of the environment. CHAS is primarily intended a user who has little background in the science of NBC hazard calculation. The operation of CHAS is described in Section 5.8 of this manual.

4.1.8.8 Run HPAC.

The Hazard Prediction and Assessment Code (HPAC) predicts hazards associated with biological, nuclear, and chemical weapons or with conventional attacks on biological, nuclear, and chemical facilities. Initially developed as a separate, standalone tool, HPAC has been incorporated into CATS and is accompanied with its own user documentation. For information pertaining to this model, please refer to the HPAC Version 3.1 or 3.2 documentation, as appropriate. Section 5.9 of this report describes the use of HPAC in CATS.

4.1.8.9 Run OSSM/Oil Spill.

The On-Scene Spill Model, Version 9 (OSSM) is an environmental simulation system designed for the rapid modeling of pollutant trajectories in the marine environment, as described in Section 5.10. The model has been integrated into CATS to simulate a limited number of pollutants. These include gasoline, kerosene, jet fuel, diesel, and light, medium and heavy crude.

4.1.8.10 Run Hurricane.

The hurricane model predicts the tracking of the storm and the damage to the areas surrounding the track of the hurricane caused by the wind. The model ingests hurricane observation and forecast data provided by the National Hurricane Center (NHC) in Miami, FL, the Central Pacific Hurricane Center (CPHC) in Honolulu, HI, or the Joint Typhoon Warning Center (JTWC) in Guam in the form of Marine Forecast/Advisory Messages. These messages are disseminated every six hours and can be accessed immediately via the National Weather Service's (NWS) Family of Services (FoS) or the NOAA Weather Wire CNWW), through various university servers on the Internet, or through a commercial vendor of meteorological data. Messages are automatically parsed by the model to extract current and forecast hurricane characteristics, including the current and forecast positions of the storm, its maximum wind speed, and the distribution of wind speeds around the storm. Radial profiles of wind speed and dynamic pressure are analyzed and calculated for each quadrant of the storm at the current and forecast positions. Accepted structural response modeling techniques have been incorporated for determining the susceptibility of a wide selection of infrastructure and residential structure types to the dynamic pressure resulting from hurricane winds. Section 6.1 provides a description on how to perform model runs.

4.1.8.11 Run Hurricane Uncertainty.

Uncertainty in hurricane track forecasts and the errors that result from that uncertainty can make a significant impact on the accuracy of damage estimates made before landfall. The Uncertainty Module allows users of CATS to determine damage probabilities as a function of the uncertainty associated with a given hurricane track forecast. This capability is currently available only for the Atlantic hurricane basin. See Section 6.4 for information on running hurricane uncertainty.

4.1.8.12 Run Surge.

Storm surge is the abnormal rise of water generated by a storm over and above the cyclical astronomical tide. For a hurricane, the surge typically has a duration of several hours and affects an area along the coast of about 100 miles. Storm surge is the phenomenon most responsible for the loss of life in a hurricane. Nine out of ten people whose lives are lost in hurricanes are killed as a result of rising waters and pounding waves. Selecting this menu item will begin the input process for performing storm surge model runs. Refer to Section 6.2 for a description on performing this model run.

4.1.8.13 Run NHC Surge.

This menu selection will begin the process of retrieving National Hurricane Center (NHC) surge estimate file and converting it into ArcView format to be displayed in a View window. This selection does not actually perform a model run, rather, it converts an NHC model run to be displayed in ArcView. The surge estimate provided by NHC are calculated as a result of data obtained six hours before landfall of the hurricane. Section 6.3 describes the process of performing the conversion.

4.1.8.14 Run Earthquake.

The Earthquake Model is a collection of programs that compute the predicted extent and degree of impact of an earthquake. These computer models and digital databases are utilized to calculate the impacts of a damaging earthquake in terms of the facilities, infrastructure, and population at risk. The Earthquake Module models the severity and the geographical extent of the damage due to the primary earthquake hazard of ground shaking as well as to the collateral hazards of ground failure, tsunami, and fire following the earthquake. Each of these hazards will calculate the physical effects of the earthquake hazard being simulated. The output will consist of raster files containing, for the types of facilities selected, the spatial distributions of the expected damage level and of the probability distribution of damage level. Section 6.5 contains information for running the earthquake model as well as detailed descriptions of each of the input parameters needed to run the model.

4.1.9 Consequence.

The commands under Consequence enable the user to calculate:

- Total numbers of casualties (Pop. Effects) associated with CHAS (nuclear, biological, chemical) and HPAC (nuclear, biological and chemical) technical hazards; and HURRICANE, EARTHQUAKE and STORM SURGE natural hazards. The casualties in each category pertinent to a given hazard type are displayed together in a separate window. Use Consequence commands is discussed in detail in Section 7 of this report. Population effects are calculated using either
  - Point Population Data
  - Polygon Population Data (Technological Hazards Only)
  - Gridded Data (Technological Hazards Only)

- Total numbers of persons at risk within the limits of all hazards and casualty/damage probabilities.

- Infrastructure assets within the limits of all hazards and casualty/damage probabilities.

- Housing units within the limits of all hazards and casualty/damage probabilities.

Point data are adequate for use with large hazards, such as those from hurricanes and earthquakes or from nuclear and biological releases, whereas polygon and gridded data are better used with small hazards, such as those from chemical releases.

4.1.10 Response, Resources, and Sustainability (RRS).

Response, Resources, and Sustainability (RRS) analysis provides emergency managers with answers to the following relief-support questions:

- What initial resources are needed to mitigate consequences of the disaster for displaced persons?
- Where are sites for sources of commodity and medical relief supplies?
- To where should the resources be delivered (mobilization sites)?

RRS is based on the extent of damage predicted for both natural and technological hazards in CATS. Table 1 below shows which hazards may be used with RRS and the population rollup method on which the RRS resource estimates are based. Initial resource assessment is limited to natural hazard models capable of generating damage probabilities. Future versions of CATS will include technological hazards in RRS analysis.

Table 1. Hazards used with RRS.

Model	RRS Initial Resource	RRS Site Query
Hurricane Damage - Probabilistic	Yes (Point Rollup)	Yes
Hurricane Damage - Deterministic	No	Yes
Earthquake Damage - Probabilistic	Yes (Point Rollup)	Yes
Earthquake Damage - Deterministic	No	Yes
Storm Surge - Deterministic	No	Yes
Technological Hazards	No	Yes

Up to date map layers (coverages) of vendors capable of providing disaster relief commodities are built into CATS and are maintained through the use of the National Decision Systems (formerly EQUIFAX) business database. Updates to these databases are available to emergency managers through FEMA.

The RRS menu also contains the Roadblock analysis command. Roadblock enables the user to identify addresses on primary and secondary roads at which to locate roadblocks intended to restrict access to a hazard area. This command requires that ArcView Streetmap be loaded in CATS.

Section 8 of this document provides a detailed description of the RRS and Roadblock calculation process.

4.1.10.1 Window.

The commands under Window are used to manage multiple active components of the CATS ArcView session. These commands are the same as those found in many Windows applications. The Show Symbol Palette command activates the screen that is used to format lines, fill and fonts. Once activated the Symbol Palette may be used to edit the appearance of any highlighted object.

4.1.10.2 Help.

The Help utility in the main CATS screen is limited to matters having to do with ArcView. Help associated with hazard and casualty prediction and assessment may be obtained by requesting the appropriate model under Hazard and selecting the Help utility in that part of CATS.

4.2 THE ARCVIEW TOOL BAR.

CATS is embedded in ArcView and is therefore able to avail itself of all the functionality of a full functioning geographic information system. Access to some of that functionality is obtained using the tool bar icons. As illustrated in Figure 26, the standard CATS tool bar consists of two rows, the upper row (buttons) deals primarily with Themes and information contained therein. The second row (tools) pertains primarily to the functionality of the cursor in performing operations in the View Window, including some operations that are unique to CATS. The functionality of the individual tool bar icons is briefly described as follows:

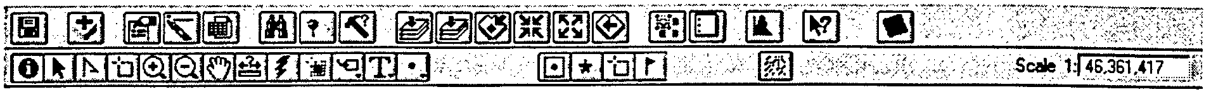


Figure 26. The CATS button and tool bar.

4.2.1 Button Row (Upper).

 Sticky-Notes is a special feature of CATS. It allows the user to create an icon and an associated text message to be placed as a theme in the active View. To use the Sticky-Notes feature in CATS, first select the hazard origin tool , place the cursor on the desired map location and click with the left mouse button. The latitude and longitude of the desired location will be reported; modify these coordinates or accept them as they appear. Next, select the Sticky-Note button . Enter text in the edit boxes provided, as shown in Figure 27, up to the maximum number of characters permitted. The first line becomes the label attached to the Sticky-Note icon in the View. Display the text by activating the Sticky-Note them, selecting the identify tool, moving the cursor to the Sticky-Note icon in the View and clicking the left mouse button. The text is displayed as shown in Figure 28.

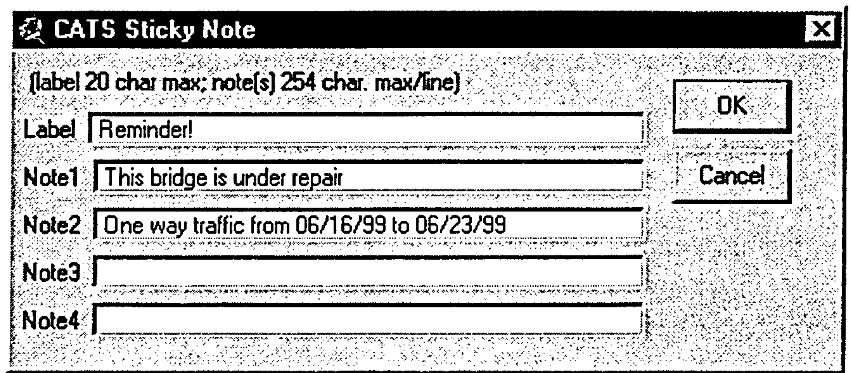


Figure 27. CATS Sticky-Note text entry screen.

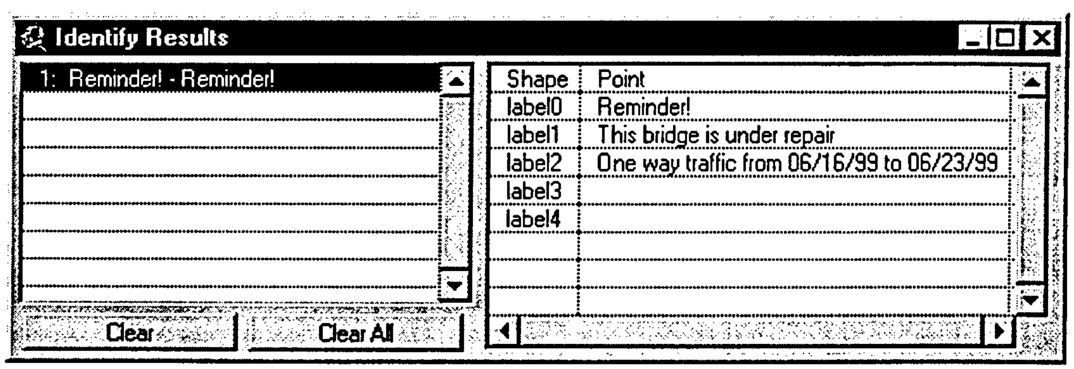


Figure 28. Display the Sticky-Note text using the identify tool.

To remove the sticky note, activate the theme in the table of contents, select ***Delete Themes*** in the **Edit** menu. Be careful that only the desired theme is active.

The remaining buttons are briefly described as follows:

 Save current project

Inserts Themes into the View

Displays dialogue box to edit properties of the **active Theme**; the active Theme is that Theme in the View Window Table of Contents which is highlighted, i.e., the entire entry appears to be raised.

Displays the legends of the active Themes

Opens tables associated with the active Themes

Finds features in the active Themes using the text you enter

Locates an address in active, matchable Theme (with ArcView Streetmap)

Displays the query builder to select features with a logical expression

Zooms to the extent of all Themes in the View Window Table of Contents

Zooms to the extent of the active Theme

Zooms to the extent of selected features in the active theme

Zooms in on the center of the current View by a factor of 2.0

Zooms out from the center of the current View by a factor of 2.0

Returns to the previous extent of the View (Undo zoom)

Selects features from the active theme(s) underneath selected graphics drawn on the View; feature highlight (change color) on the View when they are selected

De-selects features from the active theme(s)

Creates a histogram chart of the active grid theme

Gets help about any CATS button, tool or menu choice

Sticky note button

4.2.2 Toolbar Row (Lower).

Displays the attribute values of a feature of an active theme displayed in a View, Table or Chart

Reshape a feature of an active theme or a graphic by moving, adding or deleting vertices

Add, modify graphics vertices

Select features from active themes in the View

Zoom in on the current View, centered on the position or area delineated with the cursor

Zoom out from the current View, centered on the position or area delineated with the cursor

Pan in the current view by clicking and dragging the display in any direction with the mouse

Measures distance on a View (values depend on View Properties/Map Units and Distance Units settings)

Assign a Hot Link from an active feature in a View to supporting data or application

Set the Area of Interest for a View containing library-based themes

Label a feature in an active theme; text for the label is taken from the label field specified in the theme's attribute table

Add or edit text on the active View; with the text active, select Window/Show Symbol Window to edit fonts

Add graphics to the active View; select from Point, Straight Line, Line with Two or More Vertices, Rectangle, Circle and Polygon

Identify the location of a technological hazard event and activate the Rapid Hazard Analysis tool

Identify the location of a technological hazard event and identify the location of an earthquake epicenter; use prior to selecting most Technological and Earthquake hazard applications under Hazard; Latitude and Longitude values selected are automatically ingested into application input; use subsequently to running ALOHA; **Note: HPAC event location must be entered manually**

Set the Area of Interest for Earthquake damage; use prior to selecting Run Earthquake under Hazard; creates geology file for Earthquake calculation; **Note: The epicenter MUST BE INCLUDED within the Area of Interest for Earthquake damage.**

Identify the locations of the start and end of the active fault line segment; used twice in sequence, this tool establishes the angle of the fault line, which is automatically ingested into Earthquake input (default = 135 degrees)

Create a line of constant value (a contour line) from a point selected on an active grid theme

Finally, the scale may be entered directly in the Scale 1: 35,868,840 -88.30 54.08 Scale window at the right of the lower tool bar line; enter the desired value and hit Return. At the far right of the lower tool bar line is a continuous read out of the cursor location in the active View.

4.3 THE VIEW WINDOW.

The active View in CATS includes an area in which all active Themes are on display and a Table of Contents, which describes the Themes and from which the active Themes are selected.

Using the right mouse button, click on the View title bar icons to maximize, minimize or close the active View. Use the Window command button to transfer between active Views.

Check the small box at the left of a Theme in the Table of Contents to "turn on" (make visible) the Theme in the View.

Using the left mouse button, click within the boundaries of a Theme in the Table of Contents to highlight that Theme. When highlighted the entire Theme area will appear to be raised. Hold down the shift key to highlight multiple Themes.

A Theme must be highlighted in order to perform certain types of analysis within the CATS using native ArcView commands, including obtaining underlying data using the information tool and "roping" a subset of Theme constituents, i.e., selecting specific members of a Theme.

SECTION 5

TECHNOLOGICAL HAZARDS

CATS contains applications for calculating the spatial and temporal distributions of many types of technological hazards, i.e., hazards which are man-made. These applications may be executed using the Rapid Analysis tool, which predicts a variety of hazards with a minimum of user input. Alternatively, the user may choose from the list provided under Hazard in the command line at the top of the CATS View Window described in Section 4. In some cases, such as chemical hazards, CATS contains more than one model describing the extent and intensity of the hazard. Multiple models for the same hazard are necessary, because no single model has been proven to be most correct for all applications. Further, the model from which results are deemed acceptable varies from one government agency to another. However, as a general rule, results of straight-line Gaussian dispersion models are questionable beyond one kilometer and should be given no credence beyond ten kilometers.

The current suite of applications for calculating technological hazards available in CATS is as follows:

Rapid Hazard Analysis – Runs various models depending on hazard type

Hazard Area – User-defined geographic area, does not involve any model

High explosive - Blast damage model for a single explosion on open ground

NAERG Hazard Area - North American Emergency Response Guide (NAERG) protocol for defining spatial limit of toxic industrial material hazards for operational guidance

ATP-45 Hazard Area - NATO protocol for defining spatial limit of weapons of mass destruction hazards for operational guidance

D2PC Chemical Hazards – Federal Emergency Management Information System (Army) straight-line Gaussian plume code. Note: A D2PC run also generates either an ATP-45 or NAERG hazard area, depending on hazard type

Areal Locations of Hazardous Atmospheres (ALOHA) - Environmental Protection Agency, National Oceanographic and Atmospheric Administration and the National Safety Council straight-line Gaussian plume code with added buffer area for operational guidance

Comprehensive Hazard Assessment System (CHAS) - Contains the Air Transport of Radiation (ATR6) and NewFall models of initial and residual radiation hazards from nuclear weapons, respectively, Defense Special Weapons Agency Manual 1 models for blast and thermal hazards from nuclear weapons and VLSTRACK 2.1, a Gaussian multi-puff model for propagation of chemical and biological hazards. Note: A CHAS run also generates an ATP-45 hazard area.

Hazard Prediction and Assessment Capability (HPAC) – A Gaussian multi-puff model, specifically treating uncertainties in the propagation of nuclear, biological and chemical hazards from facilities and weapons

On-Scene Spill Model (OSSM) - Rapid modeling of pollutant trajectories in the marine environment.

In addition to hazard models, CATS contains systems for assessing the casualties associated with radiation, chemical and biological hazards. These systems, listed below, are operated in tandem with the hazard models, to produce spatial distributions of both hazard level and casualty probability.

Radiation-Induced Performance Decrement (RIPD) - Assessment of mortality and personal performance perturbation resulting from acute and protracted exposure to ionizing radiation (used with CHAS and HPAC output).

NewCas - Assessment of mortality, incapacitation, visual impairment and symptom threshold associated with exposure to military biological and chemical agents (used with CHAS and HPAC output).

5.1 RAPID HAZARDS ANALYSIS.

The Hazards Analysis command allows the user to predict the extent of chemical, biological, radiobiological, nuclear weapon and high explosive hazards, rapidly and easily. It is intended to reduce the complexity of hazard analysis to the level of "Point and Click," allowing the user to specify the location of an event with the cursor, select the type of event, agent name and amount and execute. The hazard and associated casualty probability or damage footprint is then automatically loaded into the active view.

Select the ***Rapid Hazards Analysis tool*** to activate the Hazards Analysis input screen and cursor. Position the cursor over the intended target in the active view and click the left mouse button. This updates the latitude/longitude value displayed in the Hazard Analysis input screen, in any of its hazard options, as illustrated in Figure 29.

Also as illustrated in Figure 29, some aspects of the Hazard Analysis input screen change depending on hazard type. Chemical and biological source quantities are input in terms of kilograms. Radiological substances are input in terms of Curies (Ci) of activity. Nuclear weapon size is input in terms of equivalent energy of kilotons (kT) of TNT, and high explosive size is specified in terms of equivalent energy of pounds of TNT. The user should input the total available source quantity. The code assumes that

- Toxic industrial material is released entirely, in an instantaneous, ground level explosion
- Chemical weapon agents are dispersed in an instantaneous, ground level explosion with an efficiency of sixty percent
- Biological weapon agents are dispersed in an instantaneous, ground level explosion with an efficiency of one percent and an agent purity of one-tenth of one percent, hence only one part in one hundred thousand of the total biological source quantity is actually assumed to be transported away from the release location
- Radiological substances are released entirely, in an instantaneous, ground level explosion
- Cobalt 60 specific activity: 1.14×10^6 Ci/kg
- Cesium 137 Specific activity: 8.69×10^4 Ci/kg
- 1 Curie (Ci) equals 3.7×10^{10} Bequerels (Bq, disintegrations per second)
- Nuclear weapon detonations occur singly at ground level
- High explosive detonations occur singly at ground level

Calculational models called by Rapid hazard Analysis depend on hazard type. D2PC applies only to toxic industrial chemical hazards and is intended to quickly assess hazard limits. HPAC is a sophisticated hazard assessment code that treats chemical/biological weapon agent hazards. HPAC calculates distributions of hazards and effects probabilities. HPAC is also used to calculate the extent of radiobiological hazards. Prompt effects of nuclear weapon detonations are calculated using the ATR6 code.

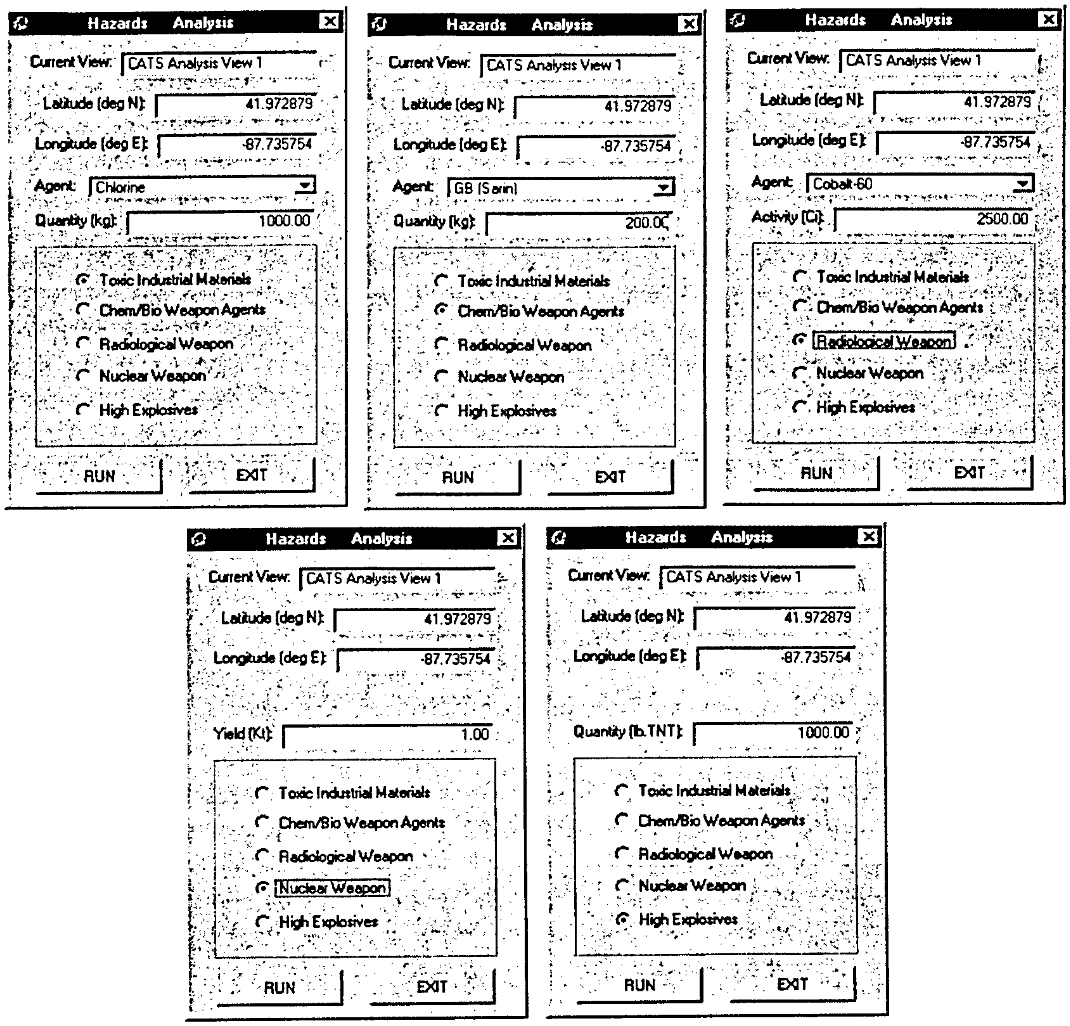


Figure 29. Rapid Hazard Analysis input screen as it appears in five technological hazard prediction options.

The user does not have control over the starting time of the event to be calculated. Rather, that time is determined from the computer clock, adjusted to the time zone in which the event occurs. Currently, standard time is assumed; the code does not account for daylight savings time.

Select ***RUN*** to Execute the calculation. The user may initiate as many calculations as desired during the rapid hazard analysis session, each being different from the last. The user may even make ArcView the active screen and perform tasks therein without exiting hazard analysis - direct. Return to the rapid hazard analysis screen to perform more hazard calculations; re-select the tool if necessary in order to select new event locations, or enter the locations manually if desired. End the rapid hazard analysis session by selecting ***EXIT***.

How Rapid Hazard Analysis gets the weather input required for chemical, biological and radiological hazard calculation depends on whether the user specifies true or false to network access in CATS Preferences. If the user specifies true, i.e., that network access is available, CATS automatically searches for NOAA weather reporting sites within half a degree (~ 50 km) of the target location and sends the wind speed, wind direction, cloud cover and temperature. If no acceptable site is found within the specified area, the user is warned of this fact and instructed to change CATS Preferences to reflect no network access before re-running the calculation. If the user

specifies false, i.e., no network access is available, CATS does not search for weather data. Rather, the user is presented with a weather input screen, wherein wind speed (m/s), wind direction (direction from which the wind is blowing), cloudiness (CL for clear, PC for partly cloudy, OC for overcast) and temperature (degrees Centigrade) may be entered manually. The default values provided are instructive and not necessarily recommended. No meteorological information is required for the nuclear weapon or high explosion hazard calculations.

The Rapid Hazard Analysis calculation runs to completion and displays the results in the active view without further user interaction (with the exception of manual weather entry, if such is required). Typical legends for toxic industrial materials hazards calculated using D2PC are illustrated in Figure 30. Toxic industrial materials (TIMs) hazards are displayed as contours, showing the spatial extent of exposure levels corresponding to immediate danger to life and health (IDLH), permissible exposure limit (PEL), and short term exposure limit (STEL). All these TIM exposure criteria are established by regulatory bodies and do not necessarily correspond to specific health effects.

Figure 30. Legend for toxic industrial material hazards.

Another type of output accompanies that from D2PC, this is a hazard area extent defined for TIMs by the North American Emergency Response Guide (NAERG), a document published jointly by the departments of the transportation of the United States, Canada and Mexico. This hazard area is not calculated using dispersion codes. Rather, it represents the likely outer limits of such calculations, taking into account a variety of uncertainties, including meteorological conditions. An example legend for this hazard area is shown in Figure 31.

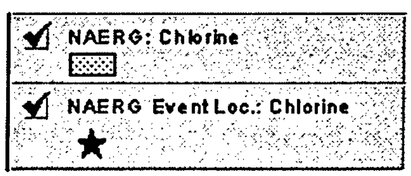


Figure 31. Legend for a NAERG toxic industrial material hazard area.

Typical legends for chemical/biological weapon agent hazard types calculated using HPAC are illustrated in Figure 32. The output of these calculations includes the dosage determined over the maximum duration of plume transport or twenty-four hours, whichever is less, and the probability of attaining threshold for noticeable symptoms (chemical agents) or causing mortality or incapacitation (biological agents), assuming no medical intervention. The dosage is presented at criterion levels corresponding to ninety and fifty percent lethality (LCt90 and LCt50) and fifty and five percent incapacitation (Ict50 and Ict5), depending on agent type. The displayed dosage is taken from the clipped Gaussian distribution calculated by HPAC according to the specific probability value set in CATS Preferences. A setting of 0.01 means that there is only a 1% probability that the coverage for a specific criterion exceeds that shown. Conversely, there is a 99% confidence that the coverage shown for a specific criterion includes all parts of the plume that meet or exceed the criterion. Thus, a low probability value is typically used to assure safety, while a high value is typically used to assure high probability of attaining the criterion value. Effects are calculated as the expected value, with no associated uncertainty. This is done by integrating the product of the dosage-dependent effects probability and the dosage Gaussian distribution over all possible dosage. This integration is performed at each calculation grid point and the results displayed as contours set at intervals of ten percent.

Note: HPAC calculations run under the CATS Rapid Hazard Analysis option create a temporary project file HPACTMP.PRJ in the current CATS working directory. This file may be opened using HPAC or loaded into CATS with more display options using HPAC LOAD.

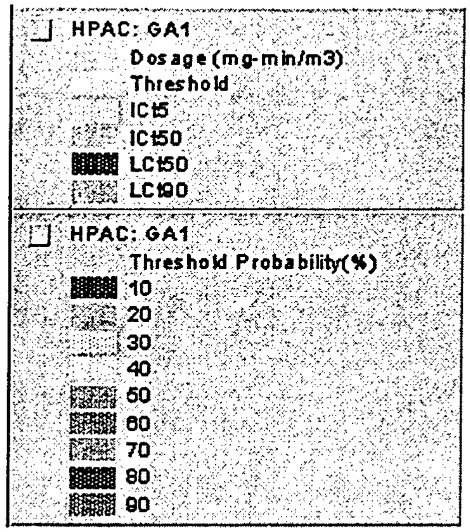


Figure 32. Legends for HPAC chemical and biological weapons hazards, effects probability (upper) and most likely dosage (lower).

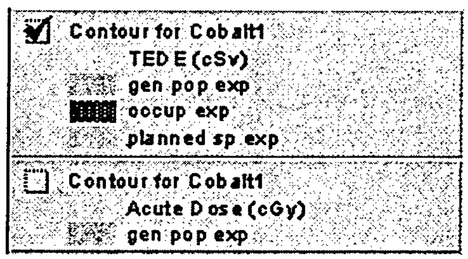


Figure 33. Legends for HPAC radiological weapon hazard, most likely dosage (upper) and effects probability (lower).

Typical legends for radiological weapon hazard calculated using HPAC are illustrated in Figure 33. The output of these calculations includes the dose, in terms of Total Effective Dose Equivalent (TEDE) and Acute Dose, determined over the maximum duration of the plume or twenty-four hours, which ever is less. The displayed dosage is taken from the clipped Gaussian distribution calculated by HPAC according to the specific probability value set in CATS Preferences. The TEDE includes that from external exposure and the 50 year committed dose equivalent from internal exposure and is represented by limiting values for annual occupational exposure limit (occup exp.), annual general population exposure limit (pop exp.) and planned special exposure. The Acute Dose includes only that from external exposure and represents a value as might be recorded by an unshielded radiation monitor. Criteria used to represent Acute Dose are levels corresponding to inability to perform complex tasks (combat imp.), fifty percent probability of lethality (LD50), one percent probability of lethality (deaths poss.), onset of radiation sickness symptoms (rad sick), annual occupational exposure limit (occup exp.), and annual general population exposure limit (pop exp.).

Typical legends for prompt nuclear weapon hazards calculated using ATR6 are illustrated in Figure 34. The output of these calculations includes the probability of effect and levels predicted for three hazard types, ionizing radiation dose in units of cGy (1 cGy equals 100 rads), blast peak overpressure in units of pounds per square inch (psi), and thermal radiation fluence in units of calories per square centimeter (cal/cm2). The effect calculated for radiation exposure is mortality, assuming no shielding and no medical intervention. Mortality probability is displayed in ten percent intervals. Ionizing radiation dose is depicted according to criteria for ten, fifty and ninety percent mortality (LD10, LD50, LD90). Peak overpressure is depicted at fifty percentile criteria levels for

producing either lethality or serious injury from displacement with impact against a rigid object or from tumbling. Thermal radiation is depicted at criteria for injury threshold (burns) and fifty percentile levels for producing serious injury or lethality. Note: All nuclear effects are calculated on a common radial grid, the extent of which is determined by the dominant effect. Small yields (< 50 kT) will cause ionizing radiation to emphasized, while very large yields (>100 kT) will cause thermal radiation to be emphasized, with blast dominating in the interim.

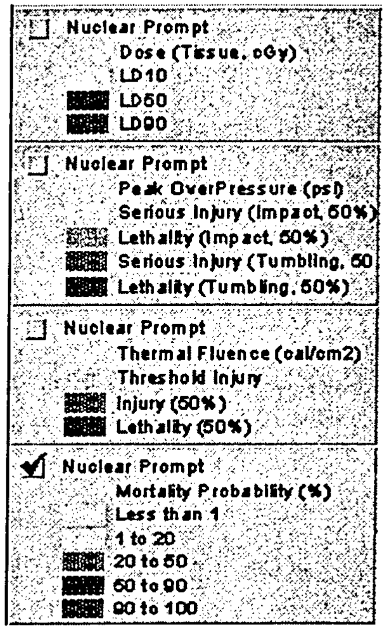


Figure 34. Legends for nuclear weapon prompt effects.

The legend for the high explosive hazard is illustrated in Figure 35. The legend shows the amount of explosive deployed and describes the blast intensity in terms of eleven types of effects. The effect requiring the highest blast level is Severe Lung Damage, that requiring the least is breaking glass.

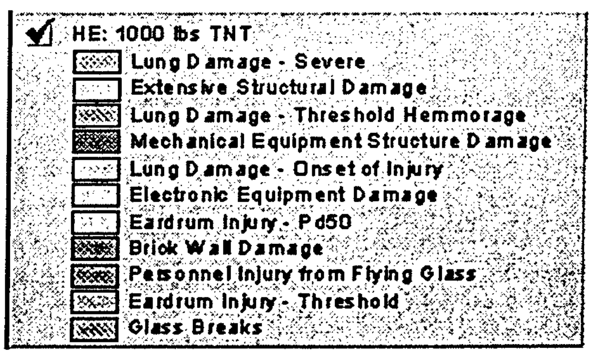


Figure 35. Legend for a high explosive hazard.

The Hazard Analysis screen is active until *Exit* is selected.

5.2 HAZARD AREA.

Define a hazard area of arbitrary shape and size using the Hazard Area application. First, create one or more graphic objects in the active view, using the ***Draw (graphic) tool*** illustrated in Figure 36. Select one or more of the graphic objects by placing the (pointer mode) cursor on them and clicking with the left mouse button. Selected graphics display markers at the four corners marking their greatest extent.

Figure 36. Draw graphic tool.

With a graphic selected, choose the ***Run Hazard Area*** command from the Hazard menu. This command converts the graphic object into a theme and places that theme in the table of contents of the active view, as illustrated in Figure 37.

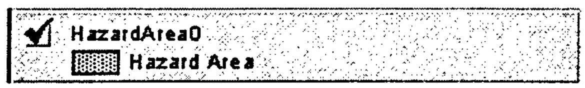


Figure 37. Hazard Area theme.

The Hazard Area theme may be used with any of the commands from the Consequences or RRS menus, with the exception of Population Effected, which requires that the hazard be expressed as a effect probability.

5.3 HIGH EXPLOSIVE

The High Explosive model will estimate the collateral damage as a result of a large explosion. The model predicts the damage based on the equivalent amount of TNT combusted.

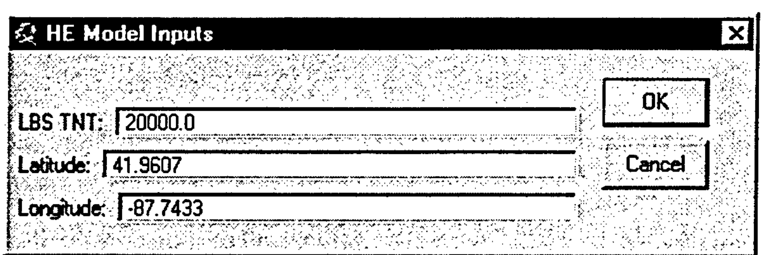


Figure 38. High Explosive Model Input Window.

Select the location of the event using the NBC Hazard Origin tool in the View tool bar. Selecting ***Run High Explosive*** from the Hazard drop down menu will open the High Explosive Model Input window as shown in Figure 38. Enter the pounds of TNT. Edit or enter the latitude and longitude of the explosion. Select ***OK*** to start the damage calculations.

The output quantities associated with the high explosive damage calculation are shown in Figure 39. Each is represented by a maximum radius to effect in the current View.

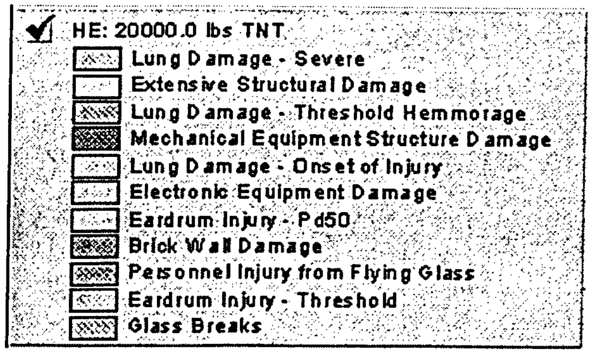


Figure 39. High Explosive output quantities.

5.4 NAERG HAZARD AREA.

The North American Emergency Response Guidebook (NAERG) was developed jointly by Transport Canada (TC), the U.S. Department of Transportation (DOT) and the Secretariat of Communications and Transportation of Mexico (SCT) for use by firefighters, police, and other emergency services personnel who may be the first to arrive at the scene of a transportation incident involving toxic industrial materials. It enables the user to quickly identify the specific or generic hazards of the materials involved in the incident and provide protection for both first responder and the public.

The ***Run NAERG*** selection under the Hazard drop down menu will obtain the area contained within the Isolation and Protective Action Distances specified by the North American Emergency Response Guidebook for use in case of toxic industrial material releases. This simple construct is intended to support the needs of the first responder to define the area in which some action may be required in the short term. The size and orientation of this area depends on the agent, the amount released, wind direction and whether the release occurs during the day or night.

To run NAERG under CATS, first select the event location using the cursor and the Hazard Origin tool in the view tool bar. The user must use this tool if meteorological data are to retrieved automatically, in which case the Net connection must be active and acknowledged in CATS User Preferences. Click on the desired location in the view and a window will appear containing the latitude and longitude of that location. The selected location will be used as the event location in NAERG.

Upon selection of ***Run NAERG,*** the NAERG Toxic Materials window, shown in Figure 40, will open. Select the desired substance and press ***OK*** to continue or ***Cancel*** to cancel the operation.

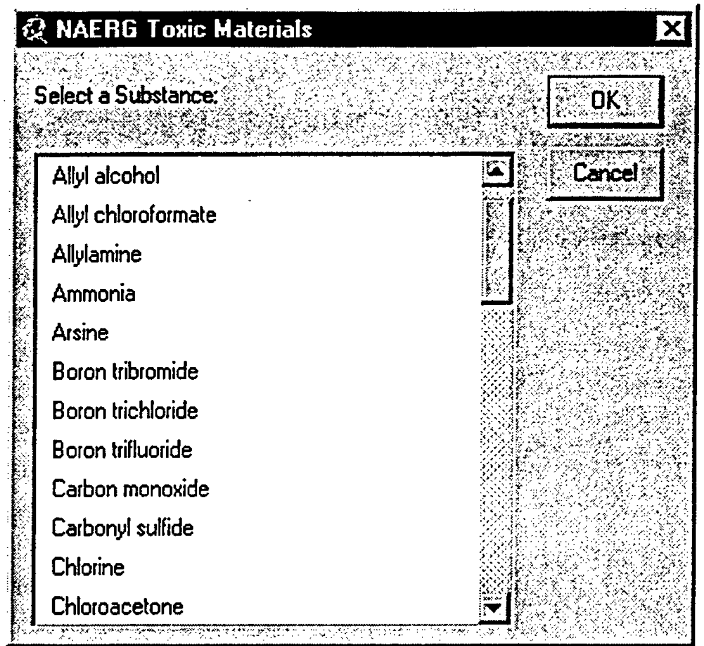


Figure 40. NAERG toxic industrial materials list.

In the NAERG Release Parameters window (Figure 41) select either a large (greater than 200 kg) or small release, the date of the release (mm/dd/yyyy) and whether the release occurs during daytime or at night.

Note: 200 kg is approximately the contents of a 55 gallon drum for a unit density liquid. Finally, enter or edit the location of the release event in decimal degrees, latitude and longitude.

Note: If the user enters the location manually, the "Get Met data from nearest sites" option should not be used and the met data should be entered manually. Select OK to continue.

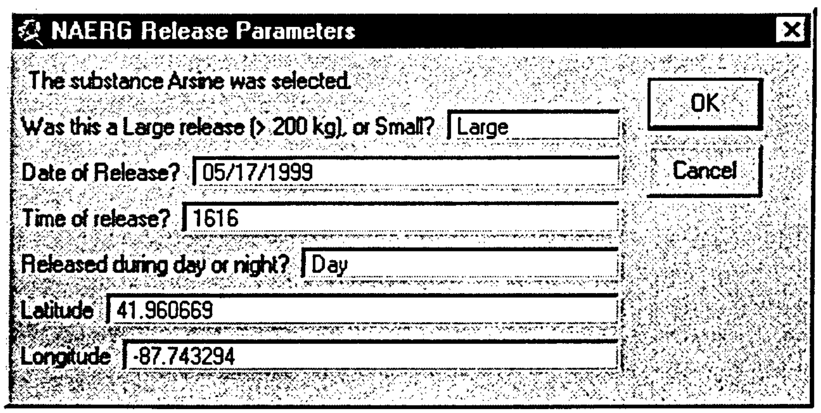


Figure 41. NAERG chemical release event parameter input window.

If the system Net connection is active and acknowledged in CATS User Preferences, the user will be provided the opportunity to use real-time weather retrieved from nearby NOAA reporting stations or entering the wind direction manually. If the weather retrieval option is selected the user will be presented with a list of all the locations having complete data in ascending order according to distance from the hazard location. Select and accept the desired data to be shown an edit box with the wind direction (Figure 42). View, edit or, if the manual option has been chosen, enter the wind direction for the event.

Note: Wind direction is that from which the wind is coming.

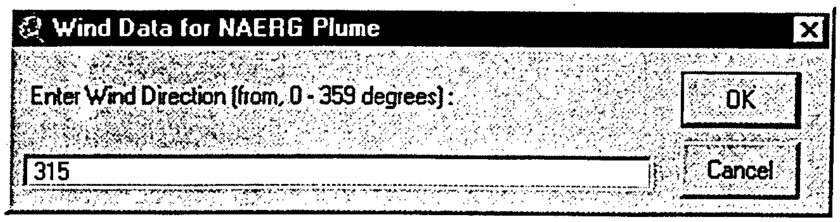


Figure 42. Wind direction specification for NAERG.

After selecting *OK*. The model will perform its calculations. After the calculations are finished, a "Done" window will open notifying the user of completion of the model run.

The output from a NAERG calculation is a hazard area in the shape of a "fan." The size and shape of the fan are affected by agent type but not meteorological conditions. The direction of the fan is that of the prevailing surface wind, it is not the result of a dispersion calculation. Rather, it is constructed using standard dimensions, based on conservative assessments of uncertainties.

5.5 ATP-45 HAZARD AREA.

Each time a CHAS application or D2PC is run for a military agent source, an Allied Tactical Protocol 45 (ATP-45) fan or circle is also generated. An ATP-45 fan or circle prescribes areas within which exposure to a radiological, chemical or biological hazard may be of immediate operational concern, limit operations by exposed personnel, with or without protective measures, and, thereby, cause major disruptions in unit operations.

The meaning associated with segments of ATP-45 fans or circles depends on the hazard type, as follows:

Nuclear Fallout (Radiological Hazard):

Zone 1 - Zone of Immediate Operation Concern. Within this Zone there will be areas where exposed, unprotected personnel may receive doses of 150 cGy or greater, in relatively short periods of time (less than 4 hours after actual arrival of fallout). Major disruptions of unit operations and casualties among personnel may occur in some parts of this zone.

Zone 2 - Zone of Secondary Hazard. Within this Zone the total dose received by exposed, unprotected personnel is not expected to reach 150 cGy within a period of four hours after the actual arrival of fallout, but within it personnel may receive a total dose of 50 cGy or grater within the first 24 hours after arrival of fallout. Personnel with no previous radiation exposure may be permitted to continue critical missions for as long as four hours after the actual arrival of fallout without incurring the 150 cGy emergency risk dose.

Overlapping Zones - In the case of multiple bursts, the region of overlapping zones should be assigned the higher classification involved.

Location of H + 1 time of arrival - Location of initial fallout arrival, one hour after detonation.

Chemical Hazard:

Attack Area - This is the predicted area immediately affected by the delivered chemical agent on land.

Hazard Area - This is the predicted area in which unprotected personnel may be affected by vapor spreading downwind from the Attack Area. The downwind distance depends on the type of attack and the weather and terrain in the attack area and the area downwind of the attack area.

Biological Hazard:

Zone 1 - The area in which casualties among unprotected personnel will be high enough to cause significant disruption, disability, or elimination of unit operations or effectiveness. Priority medical treatment may be required. Units in this zone should increase their protective postures during the period of greatest hazard or upon alert if near the attack area. The end line for Zone 1 is the 20 - 30% casualty line.

Zone 2 - The area in which the aerosol cloud is dispersed to a degree at which the majority of unprotected personnel will not receive an infective (pathogen)/effective (toxin) dose of the agent, including all areas in which hazards to unprotected personnel are likely to exceed negligible risk levels under an aerosol disseminated attack. The end line for Zone 2 is the 1 - 3% casualty line.

Note that, while the size and shape of the ATP45 areas are affected by meteorological conditions and agent type, and the direction of the fan is generally that of the prevailing surface wind (except in the case of low wind speed, when the fan becomes a circle), it is not the result of a dispersion calculation. Rather, it is a construct, based on conservative assessments of uncertainties.

In the case of toxic industrial materials, NAERG fan is calculated and displayed along with the D2PC results, as described below.

5.6 D2PC CHEMICAL HAZARDS.

D2PC is a chemical dispersion code developed by the Army to calculate hazards associated with accidental release of chemical agents from arsenals, production facilities, or other types of storage. D2PC has a capability to calculate hazards from explosions or spills involving accidental release of military and industrial agents.

To run D2PC under CATS, first select the event location using the cursor and the Hazard Origin tool in the view tool bar. Click on the desired location in the view and a window will appear containing the latitude and longitude of that location. The selected location will be used as the event location in D2PC.

Next, select ***Run D2PC*** from the HAZARD menu.

Select the desired chemical agent from the list of military and toxic industrial material agents provided in the list illustrated in Figure 43. The list is in two parts, joined sequentially. The first part contains military agent names, and the second part contains toxic industrial material names, all listed alphabetically.

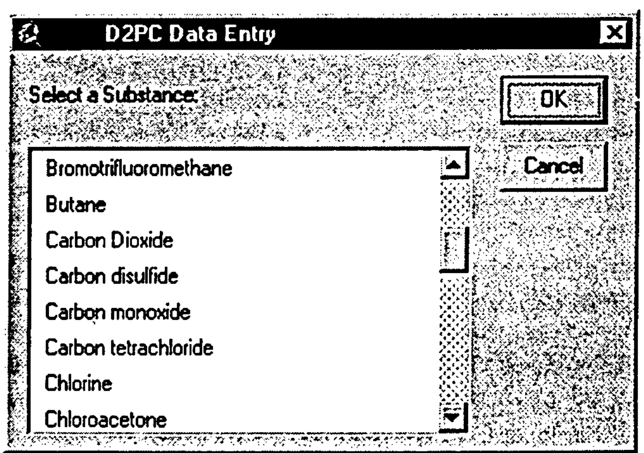


Figure 43. D2PC chemical agent input list.

The next screen (Figure 44) allows the user to specify the quantity of agent (kg). Note that 200 kg is approximately the mass of unit density liquid contained in a 55 gallon drum and 1000 kg is a metric ton. Specify the name of the theme, which will identify the results of the D2PC calculation in the table of contents of the view in which it is loaded. The next two lines of input are the latitude and longitude of the release location, in units of decimal degrees. However, the user is reminded that the location may be entered/edited manually or it may be selected using the tool in the view toolbar.

Note: If the user enters the location manually, the "Get Met data from nearest sites" option should not be used and the met data should be entered manually. To complete entries in the screen, enter the date (mm/dd/yyyy) and local time (24 hour clock) of the release and select OK to continue.

Note: Cancel will take you completely out of D2PC input, not simply back one screen.

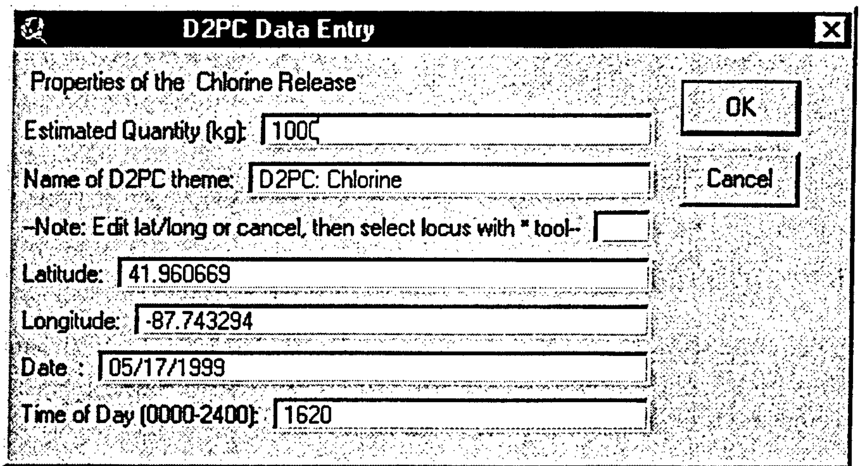


Figure 44. D2PC data entry.

Next, select one of two dispersion modes (choice will vary, depending on agent). <u>**Explosion:**</u> Instantaneous release of liquid and vapor to atmosphere, or <u>**Spill:**</u> Liquid agent release to surface with subsequent evaporation.

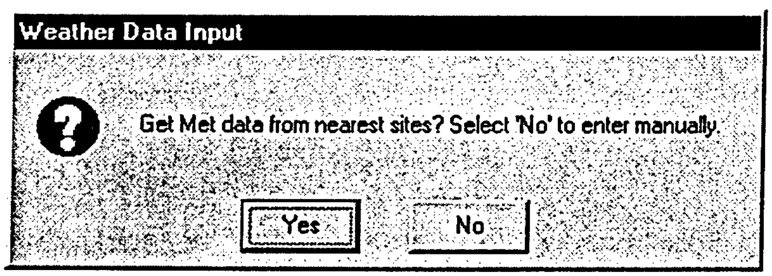


Figure 45. Weather Data Input mode selection.

If the user has Internet access, that access is active and the user has specified "True" to Internet Access in the CATS Control/CATS Preferences/CATS System Settings, the user is next given a choice of Weather Data Input mode, as illustrated in Figure 45. If *Yes* is selected, the user will observe queries to NOAA reporting locations and will be given a choice of locations containing complete data, as illustrated in Figure 46, presented in a drop down menu in ascending order of distance from the hazard origin.

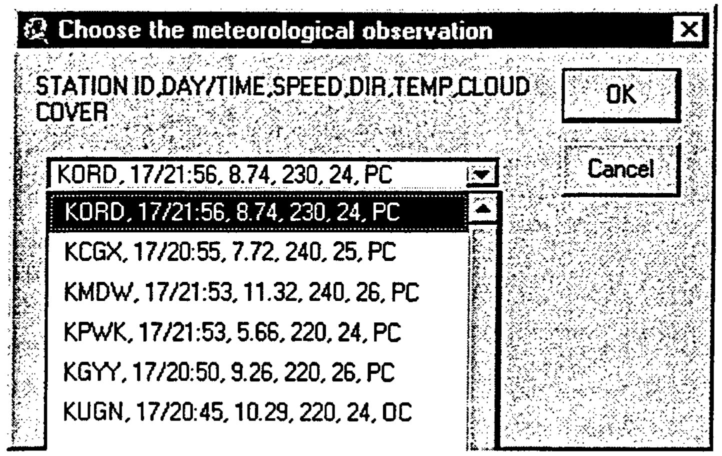


Figure 46. Choice of retrieved meteorological data as D2PC input.

Weather parameters from the selected location, including wind speed (m/s) and direction (decimal degrees), cloud cover condition of Clear (CL), Partly Cloudy (PC) and Overcast (OC), and temperature in degrees Celsius are entered automatically, as illustrated in Figure 47.

Note: Atmospheric stability and mixing height are calculated automatically from the entered parameters and appear in a window when the calculation is executed. These data may be modified in this screen. Also, if the automatic weather retrieval option is not chosen or if Net access is not available, the user will be presented with this Weather Data input screen for use with manual input.

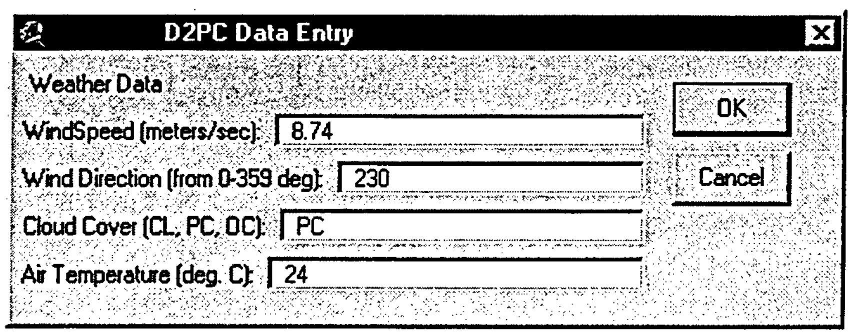


Figure 47. D2PC weather data input.

After all parameters are viewed, edited or entered, select ***OK*** to start the calculations. The user is prompted that the calculation is finished, with a "Done" window and selects ***OK*** to complete the calculation sequence.

Upon completion of the calculation sequence, as illustrated in Figure 48, D2PC hazard footprints (expected spatial distributions) are loaded into the active View. If a military agent is chosen the quantities include:

- Mortality Probability Greater Than Zero.
- Mortality Probability Greater Than 1%.
- Onset of Symptoms.

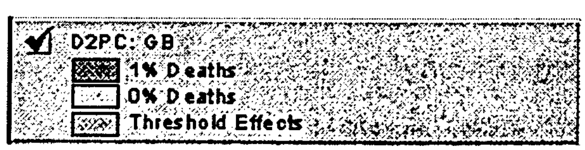


Figure 48. D2PC output quantities, military agents.

As illustrated in Figure 49, if a toxic industrial material, such as nitrogen dioxide, is chosen the footprints include

- Immediate danger to life and health (IDLH), integrated over 30 minutes maximum exposure duration, limits established by National Institute for Occupational Safety and Health (NIOSH).
- Threshold-limit-value, Permissible Exposure Limit (TLV-PEL), integrated over 8 hours maximum exposure duration, limits established by Occupational Safety and Health Administration.
- Threshold-limit-value, Short term exposure level (TLV-STEL), integrated over 15 minutes maximum exposure duration, limits established by American Conference of Governmental Industrial Hygienists, Inc.

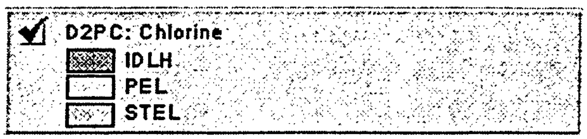


Figure 49. D2PC output quantities, toxic industrial materials.

The D2PC Theme Prefix is used in the title of each associated legend entry to uniquely identify it. The name of the shape file set (*.shp, *.shf, *.dbf) used to create the Theme is D2PC plus an index number. The user can determine the name of the shape file supporting a given theme by highlighting the theme in the table of contents and selecting Theme/Properties from the command bars at the top of the View.

5.7 AREAL LOCATIONS OF HAZARDOUS ATMOSPHERES (ALOHA).

ALOHA is released by the Environmental Protection Agency, National Oceanographic and Atmospheric Administration and the National Safety Council. It is designed for use in response to chemical accidents. As such, it can predict rates at which chemical vapors escape into the atmosphere from broken gas pipes, leaking tanks and evaporating puddles. Finally, it predicts how the resulting hazardous gas cloud may disperse in the atmosphere. The ALOHA data base contains data on approximately 900 common hazardous chemicals.
Call ***RUN ALOHA*** from the CATS Hazard menu. This executes ALOHA and presents the user with the ALOHA graphic user interface.

The basic operation of ALOHA is as follows:

- Site Data Menu:
  - LOCATION where an accidental chemical release is occurring, must be specified by city name; if the city of interest is not available in the list provided, select one having the closest Longitude.
  - BUILDING TYPE affects sheltering posture.
  - DATE & TIME must be entered or specified as taken from the system.
- Setup Menu:
  - CHEMICAL of concern must chosen the from the ALOHA Library; note that some listed chemicals do not include an exposure limit criterion value; use the Setup/Chemical/Modify command sequence to enter values for either IDLH or TLV-TWA, otherwise the ALOHA calculation cannot proceed.
  - ATMOSPHERIC information, wind speed, wind direction and temperature as minimum, must be entered,
  - SOURCE of the chemical release must be chosen from the menu provided.
- Display Menu:
  - Select the CALCULATE Command.
  - Request ALOHA to display a FOOTPRINT; this causes a file (alo_ftp.pas) to be written, which is passed to CATS for display and analysis.
- File Menu: Quit

To Load the ALOHA footprint into the CATS active View, select the CATS Hazard Origin tool move the Hazard Origin tool cursor to the location of the event and click the left mouse button to display the Latitude and Longitude of the chosen location. Edit the Latitude and Longitude if desired and accept the location by selecting ***OK***. A message box will indicate the availability of the ALOHA footprint. If it is chosen to load the footprint it will be loaded into the active View with a table of contents entry as shown in Figure 50 and the *.pas file will be erased. Note: If it is not chosen to load the ALOHA footprint, the *.pas file will remain in the CATS run directory, and the user will continue to receive the invitation to load the footprint each time the Hazard Origin tool is used. This condition can be eliminated by manually deleting the *.pas file from the run directory.

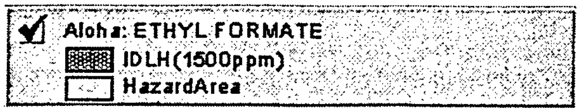


Figure 50. ALOHA output quantities, toxic industrial materials.

The ALOHA footprint includes an all encompassing Hazard Area, taking into account atmospheric dispersion uncertainty, around a contour indicating the greatest extent of most appropriate exposure limit criterion, typical definitions for which are listed as follows:

- Immediate danger to life and health (IDLH), integrated over 30 minutes maximum exposure duration, limits established by National Institute for Occupational Safety and Health CNIOSH).
- Threshold-limit-value, Permissible Exposure Limit (TLV-PEL), integrated over 8 hours maximum exposure duration, limits established by Occupational Safety and Health Administration.
- Threshold-limit-value, Short term exposure level (TLV-STEL), integrated over 15 minutes maximum exposure duration, limits established by American Conference of Governmental Industrial Hygienists, Inc.

5.8 COMPREHENSIVE HAZARD ASSESSMENT SYSTEM (CHAS).

The CHAS option in CATS contains applications for the calculation of technological hazard distributions and their translation into casualty probabilities. These applications are operated from a common graphical user interface, called from the Hazard drop-down menu in the CATS view screen. This interface input option provides the user with pre-defined options, which have been created to describe many of the more plausible occurrences in case of an event involving nuclear, biological or chemical weapons. As such, it concentrates on the "where, when, what, how" of the event description, rather than technical details, and is therefore ideal for the rapid entry of descriptive parameters. It is also ideal for the entry of input by a user who is basically untrained in hazard estimation and casualty assessment technology.

5.8.1 CHAS Nuclear.

Select ***RUN CHAS NUC*** from the Hazard Menu to permit entry of descriptive parameters associated with a nuclear explosive event, as illustrated in Figure 51. The CHAS nuclear graphic user interface executes the ATR initial radiation model, blast and thermal models consistent with DSWA Effects Manual 1, and the NewFall fallout radiation model. The CHAS nuclear graphic user interface is divided into three input sections, plus a set of command buttons at the bottom of the screen.

5.8.1.1 Description.

The ***Description*** is a forty character text field, which may be used to describe the calculation as well as providing a title for calculation output. Entry of a Description is optional. If none is entered, one is provided when the ***Save*** command button is activated, consisting of the weapon yield and fission fraction separated by a semicolon.

5.8.1.2 Source.

The Source section of the input includes the location of one or more nuclear bursts in terms of ***Latitude and Longitude,*** having dimension units of decimal degrees. The location of the burst may be selected before entering. CHAS, using the Hazard Origin tool in the CATS toolbar. Activate this tool; place the cursor at the event location; click the mouse left button and accept the displayed latitude and longitude. Select Run CHAS Nuclear and the specified coordinate values are automatically parsed to the screen as the location of the first burst. Subsequent bursts are also given the same burst location as their default location, which may be edited by the user as desired.

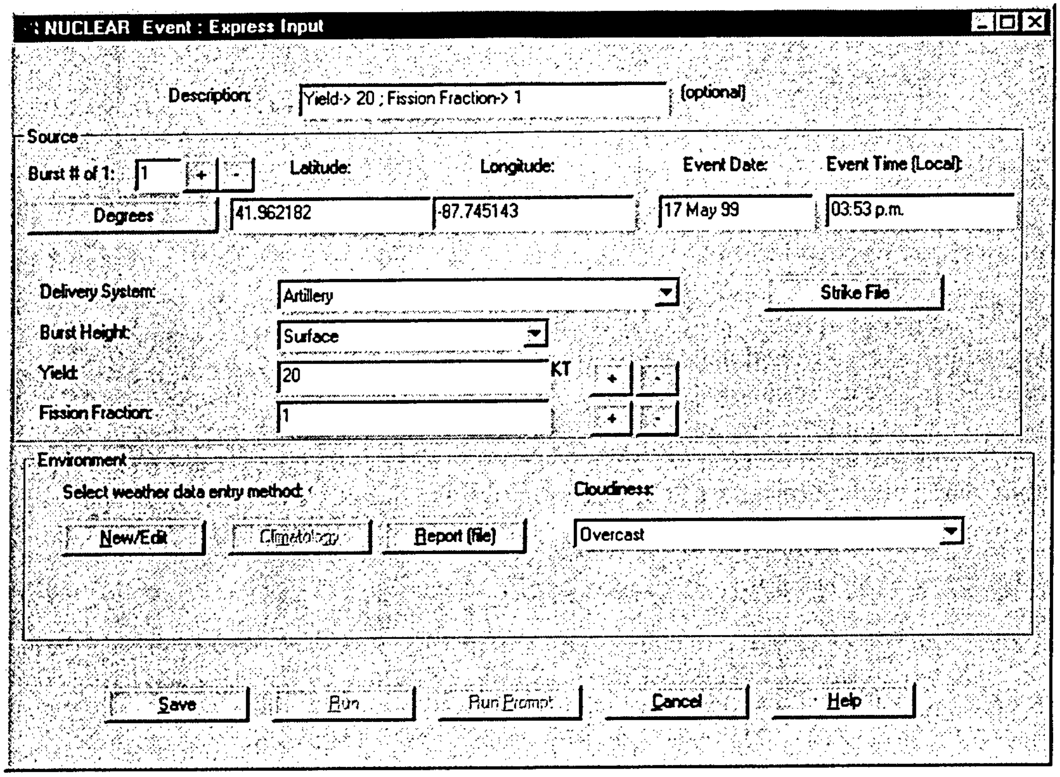


Figure 51. CHAS Nuclear input option, main screen.

The ***Date and Time*** pertain to the event location, NOT that at which the calculation is being run. The Time entry is in terms of standard time local to the event, NOT Zulu time. The burst times must run chronologically. For multiple bursts one or more times may be the same. Default time is either the current time according to the computer or the last time entered and saved. To display the current time and all other source defaults, delete the file "current" from the working directory before selecting Run CHAS NUC.

The ***Delivery System*** is specified using the contents of a drop-down menu, as illustrated in Figure 52. Note that in the case of a nuclear event the Delivery System is characterized for information purposes only and does not play a role in the hazard calculation.

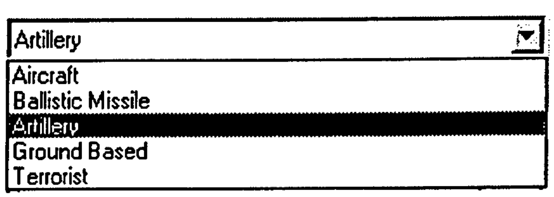


Figure 52. Nuclear delivery system menu.

The ***Burst Height*** refers to the location of the event relative to the ground surface. Available choices in the Burst Height drop-down menu are illustrated in Figure 53. ***Surface*** should be used for any explosion on or within a few meters of the ground. Choice of ***Air*** places the burst at fifty scaled meters above the ground. The term "scaled meters" refers to the actual burst height, in meters, divided by the cube root of the weapon yield in kilotons. Thus, for a ten kiloton (kT) weapon, fifty scaled meters means an actual burst height of approximately 108 meters. The significance of this burst height is that it enhances the propagation of prompt hazards, such as blast and initial radiation, while minimizing radioactive fallout. The ***User-Entered Height Value*** entry option for burst height allows the user to enter a specific value in units of feet. Note that, in the case of multiple bursts, the user is presented with the User-Entered Height Value option and may not use the other two options.

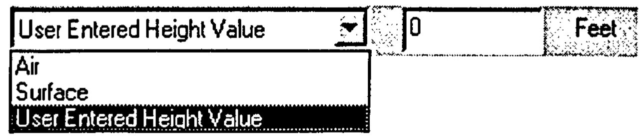


Figure 53. Nuclear burst height menu.

The ***Yield*** refers to the explosive energy of the burst, expressed in units of thousand tons (kilotons, abbreviation: kT) of TNT equivalents. The user may use the + and - buttons to increase or decrease the yield value in 5 kT increments, or he may place the cursor in the Yield edit box and enter a specific value directly. Note that a double click of the cursor in the Yield edit box will highlight the current entry, permitting any new entry to replace it completely. As a rule of thumb, the bombs exploded at Hiroshima and Nagasaki and at early tests, such as Trinity, Able and Baker, all had yields on the order of twenty (20) kT. Therefore, a yield of this order may be considered typical of entry level nuclear explosive technology.

The production of higher or lower yields requires more advanced technology. Set the yield to a value of zero to eliminate a burst. A blank entry is not equivalent to a zero value and will result in an error. The ***Fission Fraction*** refers to the fraction of the Yield caused by fission, which is the process by which a single nucleus is broken apart and the difference between the mass of the two residual parts and that of the original nucleus is converted into explosive energy. The + and - buttons may be used to increase or decrease the yield value in increments of 0.1, or the cursor may placed in the Fission Fraction edit box and a specific value entered directly. Entry of a Fission Fraction of 1.0 means that the explosion is derived 100% from the fission process. Entry of any value less than 1.0 means that the remaining fraction of the yield is due to fusion, the process by which two light nuclei are combined into a single nucleus, with the difference in mass converted into energy for the explosion. Adding any fusion component to the yield is considered to require technology more advanced than entry level.

Weapon specifications other than yield and fission fraction are as follows:

Neutron energy spectrum:	Yield < 50 kT, Unclassified Fission Yield > 50 kT, Unclassified Thermonuclear
Neutron normalization:	2.0E+23 n/kT
Gamma ray energy spectrum:	Unclassified Fission
Gamma ray normalization:	1.0E+23 g/kT
Gamma ray pulse width:	2 shakes
Fission yield fraction by isotope:	Yield < 50 kT, 1.00 U-235 Yield > 50 kT, 1.00 U-238
X ray energy spectrum:	1 keV Black Body
X ray total energy:	70% of Total Yield

The ***Strike File*** button allows the user to substitute a previously created file for the weapon described in the GUI. Select the Strike File button to enter a file service window. That window is set to look for files having the extension *.stk. Browse to find the desired file, highlight the file and Open. The strike file may contain up to 999 bursts, of different yield and fission fraction, occurring at different times and locations.

The order in time must be chronological. An example of the file is provided, as follows:

```
38.84313 -77.08987  20.00  0.000  1.0000 9705022028
38.90313 -77.08987  20.00  0.000  1.0000 9705022028
etc.
```

This file is read free format. Each line describes a burst. The entries are as follows: Latitude (Degrees North), Longitude (Degrees East), Yield (kT), Burst Height (meters), Fission Fraction (decimal fraction), Date/Time (YYMMDDHHMM, Zulu), Target type (enter 1), and Number of daughters (enter 0).

Note: In order to use this file in HPAC the user must manually add a line at the top of the file containing the string: STRIKE. This string is not permitted in the strike files used in CHAS.

Upon loading a strike file, the contents are parsed to the screen, where they may be viewed and edited. When the Save button is activated (see below), the strike file is saved to the current run directory as NUCXX.STK, where XX represents a two digit index number to differentiate between saved files.

5.8.1.3 Environment.

The Environment section allows the user to describe the vertical profile of the atmosphere, generally referred to as the "sounding." This information may either be entered manually for nuclear hazards, using the *New/Edit* button, or from a file in the HPAC grid (*.grd) format, using the ***Report(file)*** button.

The manual data entry screen for sounding parameters is illustrated in Figure 54. The column labeled ***Level (Elevation)*** provides a list of entries, each consisting of an index number followed by elevation (height above sea level in units of meters) at which sounding information has been provided. In the example shown in the figure, the sounding data consist of information at a dozen elevations. The information pertinent to each elevation may be reviewed, entered or edited by activating the button to the left of the elevation index number. The data at each elevation are as follows:

Elevation - Height above sea level in units of meters (avoid zero values, values < 0 permitted, the standard measurement height for ground level meteorology is 10 meters).
Pressure - Atmospheric pressure in units of millibars (mb).
Wind Direction - Declination from True North (DTN) of the direction from which the wind is blowing (0 ≤ values <360 degrees).
Temperature - Units of degrees Centigrade (°C).
Relative Humidity - Units of percent (%); development of selectable units to include Dew Point (°C) is in progress.
Wind Speed - Units of meters per second (m/s); development of selectable units to include miles per hour (mph) and knots (knt) is in progress.

Insert a new sounding level by selecting a new level at the bottom of the list; enter the desired values, including elevation, and ***Accept*** the new sounding data set. The new entry will be re-indexed automatically, based on the elevation value entered.

Visibility - The property that affects the transmission of thermal radiation through the atmosphere. It is defined as the horizontal distance at which a large dark object on the horizon has just enough contrast with surrounding sky to be discernible in daylight. The international code for correlating visibility with condition of the atmosphere is given in Table 2 (from Effects of Nuclear Weapons, Glasstone & Dolan: Government Printing Office, 1977). The CATS thermal radiation model is limited to yields from 0.1 kT to 25 MT, heights of burst from zero to fifteen hundred scaled meters. The CATS default visibility value is 20 km, corresponding to clear conditions. No change is allowed at this time.

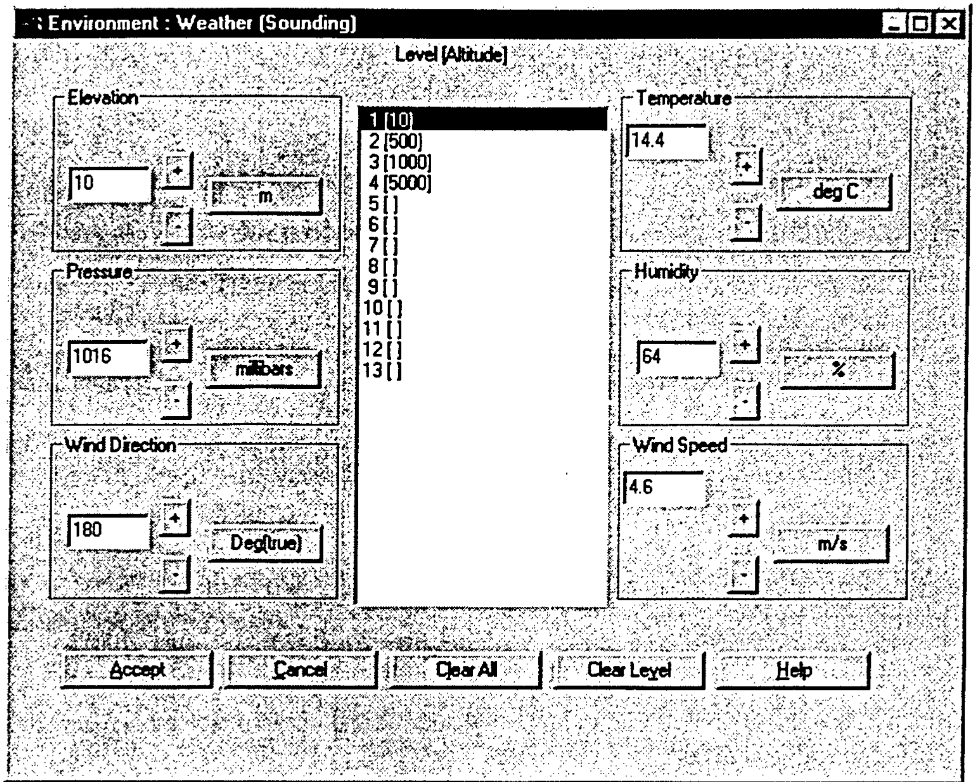


Figure 54. CHAS nuclear sounding input screen.

The ***Clear All*** button at the bottom of the sounding input screen may be used to COMPLETELY CLEAR ALL sounding entries. The ***Clear Level*** button clears all constituent parameter values in the selected level; either enter new values or leave the level untouched, in which case the level will be eliminated upon Accepting the entries.

Table 2. Atmospheric visibility.

Atmospheric Condition	Visibility (km)
Exceptionally Clear	80
Very Clear	50
Clear	20
Light Haze	10
Haze	4
Thin Fog	2
Light to Thick Fog	1 or less

After viewing, entering (deleting) or editing sounding levels and their constituent data as desired, select ***Accept*** to save entries and return to the CHAS Nuclear main screen. Select ***Cancel*** to exit the sounding input screen without saving changes.

Sounding parameters affect the distance to which initial nuclear radiation will propagate, as well as the elevation to which the cloud carrying radioactive weapon debris will rise. For yields from a few kT to a few ten's of kTs, maximum cloud heights will range from a few kilometers to ten kilometers. A megaton (thousand kilotons) yield may result in a maximum cloud height of twenty kilometers or more. Therefore, it is desirable to have sounding data that include this range of altitudes. The nuclear cloud models in CATS will use whatever information is provided, from a single level to a complex, multi-level sounding profile. Wind speeds and directions at the highest and lowest levels provided are assumed to extend indefinitely upward and downward, respectively. Other

sounding parameters are interpolated between input values and default limiting values, as shown in Table 3. User input at those levels overrides the default limiting values.

Table 3. Default atmospheric sounding limiting values for nuclear explosions.

Elevation (m)	Dry Air Density (g/cm^3)	Pressure (mb)	Temperature (°C)	Relative Humidity (%)
-1,000	1.347E-03	1,139.0	21.5	77
0	1.225E-03	1,013.3	15	77
50,000	1.027E-06	0.79779	-2.5	0

Meteorology files in the *.grd format may be retrieved from the HPAC weather server and used in CHAS nuclear. Under the Environment input section, select Report(file) as the weather data entry method. Use the file service to browse for the desired file; to select the desired file, highlight it and choose Open.

Note: Using the *.grd weather data entry method limits the user to a source (nuclear detonation) that occurs within the space and time bounds of the weather data. File spatial bounds are in latitude and longitude; time bounds are in ZULU time; CHAS nuclear source entry is in terms of latitude and longitude and local time.

Work is in progress to allow the system to obtain historical sounding data (Climatology) from files, however this option is not yet available and its call button is disabled.

5.8.1.4 Command Buttons.

Upon completion of CHAS Nuclear entries, select ***Save*** to incorporate all entries and enable execution. Next, select ***Run*** to execute a calculation of hazard and casualty probability distributions from prompt and protracted radiation and other prompt hazards, assuming an exposure period beginning at burst time and extending 24 hours. Select ***Run Prompt*** to execute only the prompt component. Note that CHAS will execute prompt hazard calculations for all bursts, regardless of burst height. Fallout calculations are executed only for bursts having scaled burst heights less than 180 feet (fallout limit scaled burst height $=180*W^{0.4}$ feet, where W is yield in kT). The CHAS nuclear output files have a base name nucoutXX, with extensions *.nuc (fallout), *.prm (prompt hazards) and *.at (ATP-45 hazard area), where XX represents a file index number, ranging from 01 to 99. The index number is assigned automatically, based on the lowest available number.

Select ***Cancel*** before ***Save*** to exit the CHAS Nuclear main screen without saving any entries or, after Saving the entries, select ***Cancel*** instead of ***Run*** to exit CHAS Nuclear screen with a problem saved but not executed.

The user may check the status of the hazard/casualty calculation by viewing the CHAS run window. As illustrated in Figure 55, the execution of a CHAS nuclear fallout hazard/prompt hazard/casualty calculation generates a run message, which announces the three portions of the calculation process and, at the conclusion of each, the total CPU time required for each. It then confirms the name of the output data file. This run message is saved to the file, **chapstat.log**, which is overwritten at each execution. If for any reason the calculation does not proceed to completion as shown in Figure 55, an error condition report file, **casualty.log**, may be interrogated to determine the problem.

```
* ================================================= *
*                                                   *
*         CONSEQUENCES ASSESSMENT TOOL SET          *
*             FOR TECHNOLOGICAL HAZARDS             *
*                << C A T S - T H >>                *
*                                                   *
*         DEFENSE THREAT REDUCTION AGENCY           *
*                  << D T R A >>                    *
*                                                   *
* ================================================= *
*                                                   *
* GENERATING THE NUCLEAR FALLOUT HAZARD DATA BASE   *
*                                  52 cpu seconds   *
* PROMPT EFFECTS: RADIATION, BLAST, THERMAL     ... *
*                                  22 cpu seconds   *
* GENERATING THE MORTALITY INCIDENCE DATA BASE ...  *
*                                 437 cpu seconds   *
* THE OUTPUT FILE IS BEING SAVED TO .............   *
*                                    nucout01.nuc   *
*                                                   *
*  (this status report is saved to chapstat.log)    *
*                                                   *
*                 F I N I S H E D                   *
*                                                   *
*            Mon May 17, 1999  04:12 PM             *
* ================================================= *
```

Figure 55. The CHAS nuclear run window at calculation completion

5.8.1.5 <u>CHAS Nuclear Output.</u>

CHAS Nuclear calculations provide the expected spatial distribution of a variety of hazards, as follows:

- **Fallout total** dose in units of cGy tissue. The value is identical to that for rads (tissue), free-in-air or kerma. The dose is integrated over a 24 hour period, beginning at the time of burst. CHAS nuclear output also provides probability of mortality for persons exposed in place to fallout radiation for the same 24 hour period, assuming exposure begins at H+1 and no protection or medical treatment is provided.
- **Prompt nuclear effects,** including initial radiation dose (cGy, tissue kerma, displayed using criteria from HPAC, USTRATCOM and NATO), mortality probability from prompt radiation exposure, blast (psi) and thermal radiation (cal/cm^2)
- **ATP-45,** hazard area specified by Allied Technical Protocol 45 for nuclear bursts.

Upon completion of the calculation the user is asked whether or not to load the results of the calculation into the active View. If the answer is ***NO*** the user is returned to the View and may use the Hazard/Load CHAS command to load those results at a later time. If the answer is ***YES*** the user is asked to provide a Theme name and a ShapeFile name. The Theme name is that which appears in the table of contents of the current View. The default Theme name is Chas_NXX:, where XX represents an index number, ranging from 1 to 99. The index number is assigned automatically, based on the lowest available number. The ShapeFile base name is assigned to a set of three files that contains all the information required to enter the calculation into the View. The default ShapeFile base names are nucXX, prmptXX and nucatpXX, and are indexed as described in the case of the theme name.

5.8.2 CHAS Biological.

Select ***RUN CHAS BIO*** from the Hazard Menu to permit entry of descriptive parameters associated with an event involving the release of biological agents, as illustrated in Figure 56. CHAS biological executes the VLSTRACK model.

5.8.2.1 Description.

The ***Description*** is text, up to forty characters, which may be used to describe the calculation and provides a title for calculation output. Entry of a Description is optional. If none is entered, one is provided upon selection of the Save command button, consisting of the agent and munition names, separated by a semicolon.

5.8.2.2 Source.

The Source section of the input includes the location of the event in terms of ***Latitude and Longitude*** having dimension units of decimal degrees. This may be selected before entering CHAS, using the NBC Hazard Origin tool ⊡ in the CATS toolbar. Activate this tool; place the cursor at the event location; click the mouse left button and accept the displayed latitude and longitude. Select CHAS Biological and the specified coordinate values are automatically parsed to the screen as the event location.

The ***Date and Time*** pertain to the event location, NOT that at which the calculation is being run. The Time entry is in terms of standard time local to the event, NOT Zulu time. Default time is either the current time according to the computer or the last time entered and saved. To display the current time and all other source defaults, delete the file "current" from the working directory before selecting Run CHAS BIO.

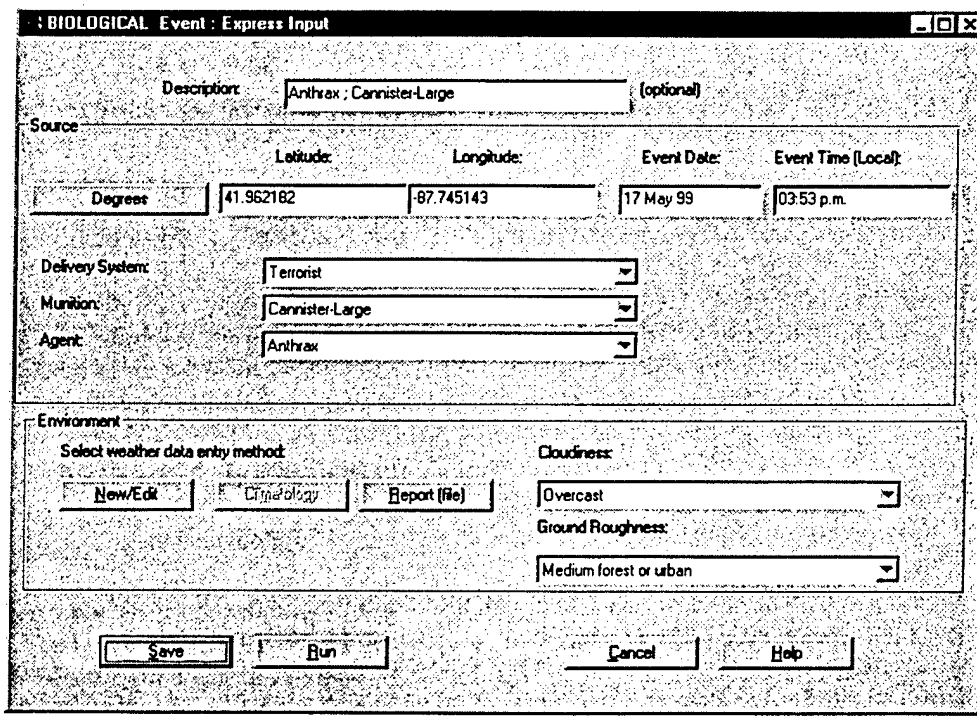


Figure 56. CHAS Biological input option, main screen.

The ***Delivery System*** is specified using the contents of a drop-down menu, as illustrated in Figure 57. Note that in the case of a biological event the Delivery System selection does play a role in the hazard calculation. Once open, a selection must be made to close the menu window.

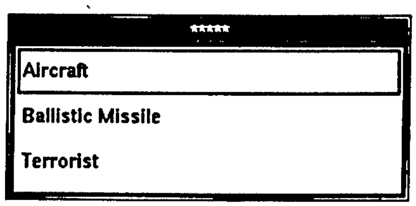


Figure 57. Biological delivery system menu.

The *Munition* or munitions associated with each Delivery system are provided in the next drop-down. There is likely to be a different kind of Munition associated with each Delivery System. This is illustrated in Figure 58, which shows windows cascaded to show the munitions associated, respectively top to bottom, with aircraft, ballistic missile and terrorist delivery.

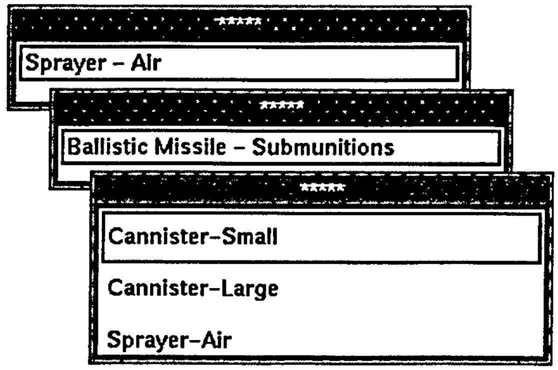


Figure 58. Biological munition menus for aircraft, missile and terrorist delivery systems, respectively.

Available *Agents* may differ from one munition to another. Biological agent types typically available are shown in Figure 59.

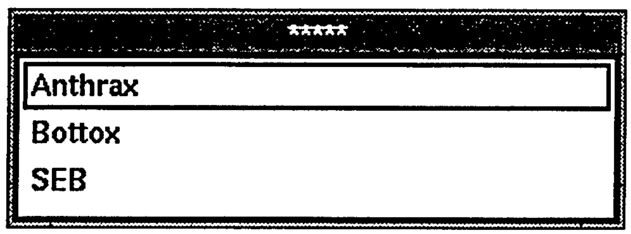


Figure 59. Biological agent menu.

CHAS Biological input features predefined source parameters. For example, specifying a ***Terrorist, Canister-Small, Anthrax*** event results in an explosion, two meters above the ground, releasing two kilograms of anthrax spores of 0.1% purity with a dissemination efficiency of one percent; the explosion instantly produces an agent concentration having a normal distribution characterized by lateral and vertical standard deviations of five meters and a particulate mass median diameter (MMD) of three microns; the distribution associated with the diameter is characterized by a Litchfield Slope (SIGD) of 1.7, i.e., in the log-normal distribution the 84th percentile diameters is equal to 1.7 times the MMD. Tables describing CHAS Biological input mode parameter value combinations may be found in Appendix B of this report.

5.8.2.3 Environment.

In the case of biological and chemical hazards the Environment section allows the user to describe meteorological conditions in two different ways. This information may be entered manually, using the ***New/Edit*** button or it may be obtained from reporting stations within half a degree of the selected hazard origin, using the ***Report(file)*** button.

The data entry screen under New/Edit for meteorological parameters was illustrated previously in Figure 54. Entries are as follows:

Elevation - Height above sea level in units of meters (avoid zero values, values < O permitted, the standard measurement height for ground level meteorology is 10 meters).

Pressure - Atmospheric pressure in units of millibars (mb) (Not currently used in biological or chemical dispersion, arbitrary value may be entered).

Wind Direction - Declination from True North (DTN) of the direction from which the wind is blowing ($0 \leq$ values <360 degrees).

Temperature - Units of degrees Centigrade (°C).

Relative Humidity - Units of percent (%); development of selectable units to include Dew Point (°C) is in progress (Not currently used in biological or chemical dispersion, arbitrary value may be entered).

Wind Speed - Units of meters per second (m/s); development of selectable units to include miles per hour (mph) and knots (knt) is in progress.

The ***Clear All*** button at the bottom of the sounding input screen may be used to **COMPLETELY CLEAR ALL** surface meteorological condition parameter values.

After viewing, entering or editing surface meteorological data as desired, select ***Accept*** to save entries and return to the CHAS Biological main screen; select ***Cancel*** to exit the sounding input screen without saving changes.

In order to use the ***Report(file)*** weather option, the user must have Internet Network access. In order to have access to current weather data that access must be active and the user **must set the CATS Control, CATS Preferences, Internet Access Setting to "true."** To obtain current weather data, the user must select the hazard origin location using the tool in the CATS tool bar. This causes CATS to search over the net for all surface weather reporting stations within half a degree of the selected location. The data from these stations are assembled in a (binary) file with a *.met extension in the 40 wind format required for input into VLSTRACK, version 2.1.2. The automatic naming convention for these files as they are created is NXXEXXXN.MET, where NXX is the north latitude (or south latitude, SXX) of the selected location in degrees, EXXX is the east longitude (or west longitude, WXXX) in degrees and N is a running index letter, which is used if a file already exists for the same location. If all twenty-six indices are in use the code will replace the "Z" index file. The user may manually change the names of the *.met files in order to archive them for future use. If this is done the user must also change the name of the companion *.ter file in an identical fashion, being careful to maintain the extension and keeping both files in the same directory. After selecting the hazard origin, the user may select Run CHAS BIO (or Run CHAS CHEM) under Hazard, select the desired event scenario and then select Report(file) under Environment options. A directory window will appear. The user must navigate to the location of the desired *.met file. New files are written to the current user directory automatically. Select and accept the desired *.met file. It and its companion *.ter file will be retrieved for use in the calculation.

Work is in progress to allow the system to obtain historical sounding data *(Climatology)* from files for use in CHAS, however this option is not yet available and its call button is disabled, however, it is available with HPAC, as described later in this section of the manual.

Cloudiness states are menu-selectable, clear, partly cloudy and overcast, as shown in Figure 60. The cloudiness state is important to biological and chemical agent dispersion, because such agents are photo-sensitive. Thus, agents dispersed in daylight under clear conditions will not propagate in the same concentration and the same extent as those dispersed under overcast conditions, all other meteorological factors being equal.

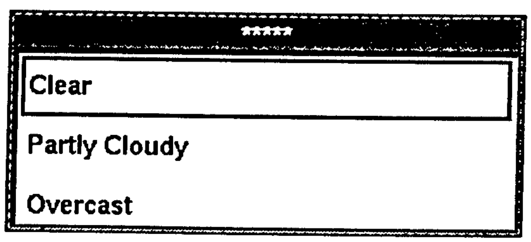


Figure 60. Cloudiness menu.

Ground Roughness describes the surface characteristics downwind from the release site. These characteristics pertain to prevalence of ground cover, foliage and structures, which affect the state of atmospheric flow in their vicinity. An increase in Ground Roughness may decrease atmospheric stability, which is calculated rather than user-specified; it also may increase the height of the mixing layer, within the confines of which the dispersion of biological agents takes place. The user must select a description from the Ground Roughness drop-down menu, as shown in Figure 61, which lists ground roughness categories in order from low to high.

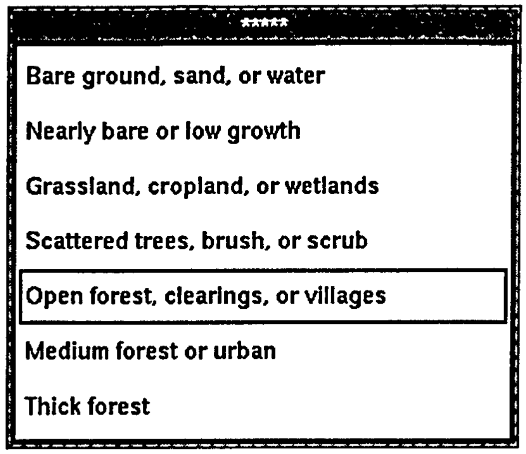


Figure 61. CHAS Biological ground roughness input menu.

5.8.2.4 Command Buttons.

Upon completion of CHAS Biological entries, select ***Save*** to incorporate all entries and enable execution; next, select ***Run*** to execute a calculation of hazard and casualty probability distributions, assuming an exposure period beginning at attack time and extending 24 hours. The output files from a CHAS Biological calculation are saved as **biooutXX.bio**, which contains the tabulated hazard and casualty probability information, and **biooutXX.vls**, which describes the VLSTRACK dispersion calculation, where XX represents an index ranging from 01 to 99. The index number is assigned automatically, based on the lowest available number. Upon completion of the calculation the user is automatically returned to the CATS view screen and prompted to display the results of the calculation (bioout.bio) in the active view.

The user may check the status of the hazard/casualty calculation by viewing the CHAS run window. As illustrated in Figure 62, the execution of a CHAS biological hazard/casualty calculation generates a run message, which announces the three portions of the calculation process and, at the conclusion of each, the total CPU time required for each. It then confirms the name of the output data file. This run message is saved to the file, **chapstat.log**, which is overwritten at each execution. If for any reason the calculation does not proceed to completion as shown in Figure 62, an error condition report file, **casualty.log**, may be interrogated to determine the problem.

Select ***Cancel*** before ***Save*** to exit the CHAS Biological main screen without saving any entries or, after Saving the entries, select ***Cancel*** instead of ***Run*** to exit the CHAS Biological screen with a problem saved but not executed.

5.8.2.5 CHAS Biological Output.

CHAS Biological calculations provide the expected spatial distribution of dosage in units of mg-minutes per meter cubed. The dosage is integrated over a 24 hour period, beginning at the time of burst. A breathing rate of 15 l/min is assumed to convert dosage to dose, as required for casualty assessment. CHAS biological output also provides the probability of mortality or incapacitation, depending on the agent, for persons exposed in place for the same 24 hour period, assuming no protection or medical treatment. This probability is output as a fraction (0 to 1.0) and displayed as a percent (0 to 100%).

```
* ====================================================== *
  *                                                    *
  *       CONSEQUENCES ASSESSMENT TOOL SET             *
  *           FOR TECHNOLOGICAL HAZARDS                *
  *              << C A T S - T H >>                   *
  *                                                    *
  *       DEFENSE THREAT REDUCTION AGENCY              *
  *                << D T R A >>                       *
  *                                                    *
  * ================================================== *
  *                                                    *
  * GENERATING THE BIOLOGICAL HAZARD DATA BASE ..... *
  *                                   35 cpu seconds *
  * GENERATING THE BIOLOGICAL CASUALTY DATA BASE ... *
  *                                    1 cpu seconds *
  * THE OUTPUT FILE IS BEING SAVED TO ............. *
  *                                     biooutO1.bio *
  *                                                    *
  *  (this status report is saved to chapstat.log)    *
  *                                                    *
  *                 F I N I S H E D                    *
  *                                                    *
 *            Mon May 17, 1999  04:47 PM              *
* ====================================================== *
```

Figure 62. The CHAS biological run window at calculation completion.

Upon completion of the calculation the user is asked whether or not to load the results of the calculation into the active View. If the answer is *NO* the user is returned to the View and may use the Hazard/Load CHAS command to load those results at a later time. If the answer is *YES* the user is asked to provide a Theme name and a File name. The Theme name is that which appears in the table of contents of the current View. The default Theme name is **Chas_BX:**, where X represents a file index number, ranging from 01 to 99. The index number is assigned automatically, based on the lowest available number. The File name is assigned to the Shape File that contains all the information required to enter the calculation into the View. It is similarly indexed.

5.8.3 CHAS Chemical.

Select ***RUN CHAS CHEM*** from the Hazard Menu to permit entry of descriptive parameters associated with an event involving the release of chemical agents, as illustrated in Figure 63. CHAS chemical executes the VLSTRACK model.

5.8.3.1 Description.

The ***Description*** is a forty character text field that may be used to describe the calculation and provides a title for calculation output. Entry of a Description is optional. If none is entered, one is provided upon selection of the Save command button, consisting of the agent and munitions names, separated by a semicolon.

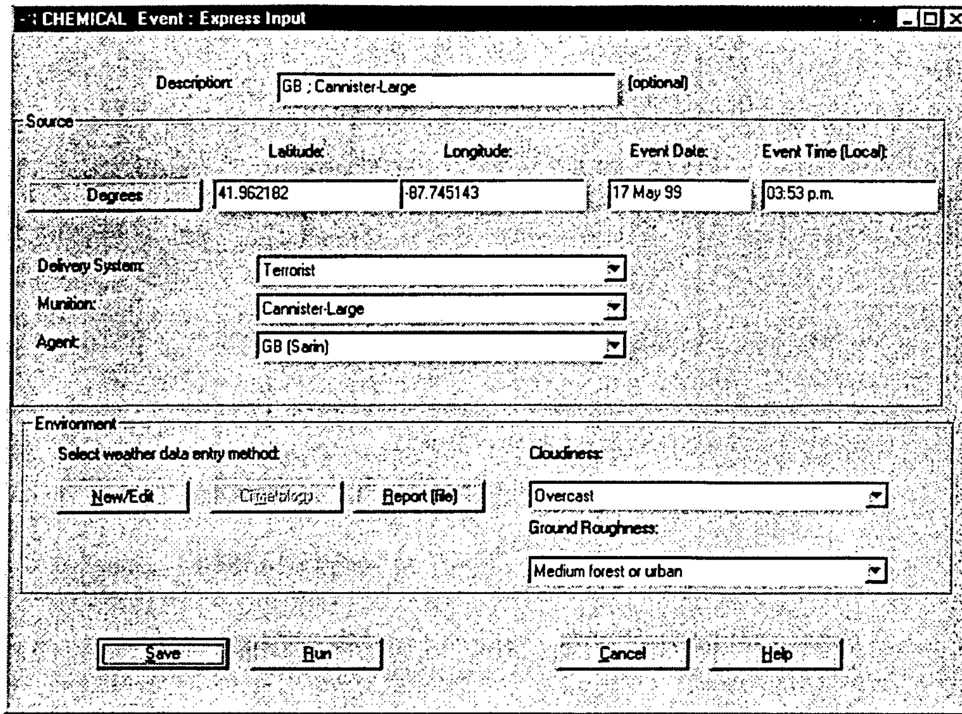


Figure 63. CHAS Chemical input option, main screen.

5.8.3.2 Source.

The Source section of the input includes the location of the event in terms of ***Latitude and Longitude*** having dimension units of decimal degrees. In order to obtain real-time weather, this must be selected before entering CHAS, using the Hazard Origin tool in the CATS toolbar. Activate this tool; place the cursor at the event location; click the mouse left button and accept the displayed latitude and longitude. Select CHAS Biological and the specified coordinate values are automatically entered as the event location.

The ***Date and Time*** pertain to the event location NOT that at which the calculation is being run. The Time entry is in terms of standard time local to the even, NOT Zulu time. Default time is either the current time according to the computer or the last time entered and saved. To display the current time and all other source defaults, delete the file "current" from the working directory before selecting Run CHAS CHEM.

The ***Delivery System*** is specified using the contents of a drop-down menu, as illustrated in Figure 64. Note that in the case of a chemical event the Delivery System selection does play a role in the hazard calculation. Once open, a selection must be made to close the menu window.

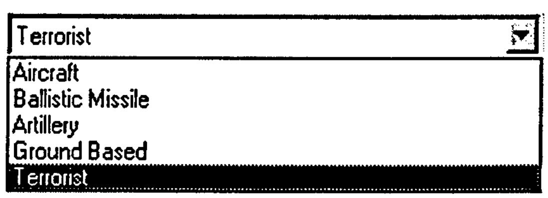


Figure 64. Chemical delivery system menu.

The ***Munition*** or munitions associated with each Delivery system are provided in the next drop-down. There is likely to be a different kind of Munition associated with each Delivery System. This is illustrated in Figure 65, which shows windows associated, top to bottom, with ground based, aircraft, ballistic missile, artillery and terrorist delivery, respectively.

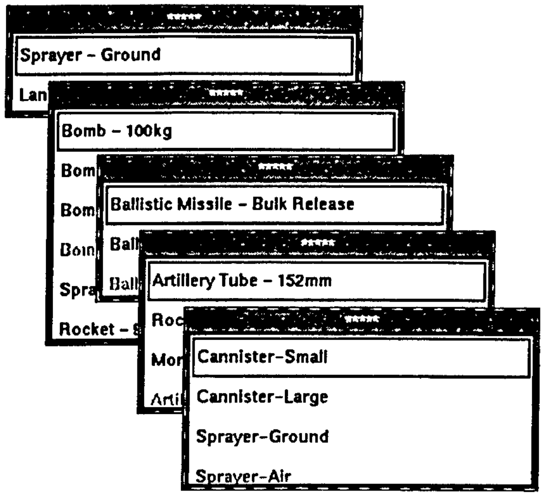


Figure 65. CHAS Chemical fireplan menu.

In the case of chemical events, the CHAS Chemical input also provides for the deployment of multiple munitions, according to a ***Fireplan***. As illustrated in Figure 64, the user may choose Fireplans for aircraft and artillery delivery of chemical munitions. Aircraft deployment options provided in CHAS Chemical, range from a single bomb, dropped by a single aircraft, to 96 bombs dropped by two aircraft. In the case of artillery the choices range from a single munition to a battalion, which is made up of two batteries.

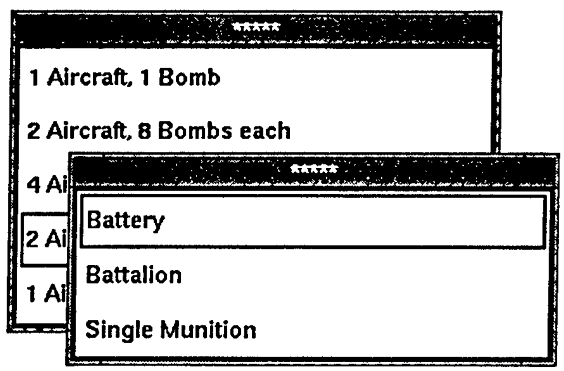


Figure 66. CHAS Chemical Munitions menu.

The available agents may differ from one munition to another. Chemical agent types typically available are shown in Figure 67. They include the "neat" form of the six most prevalent agents and the thickened form of five.

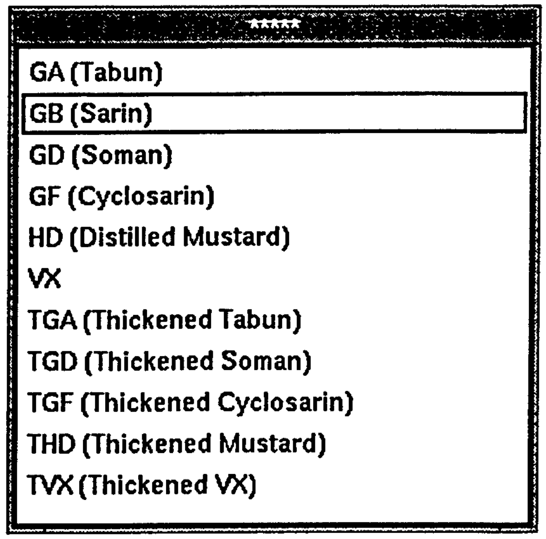


Figure 67. CHAS Chemical agent menu.

CHAS chemical input features predefined source parameters. For example, specifying a ***Terrorist, Canister-Small, Sarin Event*** results in an explosion, two meters above the ground, releasing two kilograms of Sarin agent with a dissemination efficiency of sixty percent; the explosion instantly produces an agent concentration having a normal distribution characterized by lateral and vertical standard deviations of six meters and a liquid droplet mass median diameter (MMD) of one hundred microns; the distribution associated with the diameter is characterized by a Litchfield Slope (SIGD) of 2.0. The Litchfield slope is defined as the ratio between the 84 percentile diameter and the MMD in a log-normal distribution. The vapor/liquid partition of the agent release is determined by the code used to calculate the dispersion, in this case VLSTRACK. Tables describing CHAS Chemical input mode parameter value combinations may be found in Appendix B of this report.

5.8.3.3 Environment.

The Environment section allows the user to describe meteorological conditions. The environment variables and their input are identical to those for biological events, described in section 5.8.2.3, above.

5.8.3.4 Command Buttons.

Upon completion of CHAS Chemical entries, select ***Save*** to incorporate all entries and enable execution; next, select ***Run*** to execute a calculation of hazard and casualty probability distributions, assuming an exposure period beginning at attack time and extending 24 hours. The output files from a CHAS Chemical calculation are saved as **chmoutXX.chm**, which contains the tabulated hazard and casualty probability information, and **chmoutXX.vls**, which describes parameters used in the VLSTRACK dispersion calculation, where XX represents an index ranging from 01 to 99. The index number is assigned automatically, based on the lowest available number.

The user may check the status of the hazard/casualty calculation by viewing the CHAS run window. As illustrated in Figure 68, the execution of a CHAS chemical hazard/casualty calculation generates a run message, which announces the three portions of the calculation process and, at the conclusion of each, the total CPU time required for each. It then confirms the name of the output data file. This run message is saved to the file, **chapstat.log**, which is overwritten at each execution. If for any reason the calculation does not proceed to completion as shown in Figure 68, an error condition report file, **casualty.log**, may be interrogated to determine the problem.

Upon completion of the calculation the user is automatically returned to the CATS view screen and prompted to display the results of the calculation (chmout.chm) in the active view. If the answer is ***NO*** the user is returned to the View and may use the Hazard/Load CHAS command to load those results at a later time. If the answer is ***YES*** the user is asked to provide a Theme name and a File name. The Theme name is that which appears in the table of contents of the current View. The default Theme name is **Chas_CXX:**, where XX represents a file index number, ranging from 01 to 99. The index number is assigned automatically, based on the lowest available

number. The File name is assigned to the Shape File that contains all the information required to enter the calculation into the View. It is similarly indexed.

```
* ======================================================
*                                                      *
*        CONSEQUENCES ASSESSMENT TOOL SET              *
*            FOR TECHNOLOGICAL HAZARDS                 *
*               << C A T S - T H >>                    *
*                                                      *
*        DEFENSE THREAT REDUCTION AGENCY               *
*                  << D T R A >>                       *
*                                                      *
* ============================================= *
*                                                      *
* GENERATING THE CHEMICAL HAZARD DATA BASE ....... *
*                                   38 cpu seconds *
* GENERATING THE CHEMICAL CASUALTY DATA BASE ..... *
*                                    1 cpu seconds *
* THE OUTPUT FILE IS BEING SAVED TO ............. *
*                                     chmout01.chm *
*                                                  *
*  (this status report is saved to chapstat.log)   *
*                                                  *
*                 F I N I S H E D                  *
*                                                  *
*           Mon May 17, 1999  05:01 PM             *
```

Figure 68. The CHAS chemical run window at calculation completion.

Select ***Cancel*** before ***Save*** to exit the CHAS Chemical main screen without saving any entries or, after Saving the entries, select ***Cancel*** instead *of* ***Run*** to exit the CHAS Chemical screen with a problem saved but not executed.

5.8.3.5 CHAS Chemical Output.

CHAS Chemical calculations provide the expected spatial distributions of dosage in units of mg-minutes per meter cubed and deposition in units of mg per meter squared. Each is integrated over a 24 hour period, beginning at the time of burst. A breathing rate of 15 l/min is assumed to convert dosage to dose, as required for casualty assessment. CHAS Chemical output also provides probabilities of mortality, incapacitation, visual impairment and onset of (noticeable) symptoms for persons exposed in place to dosage and deposition for the same 24 hour period, assuming no protection or medical treatment. These probabilities are output as fractions (0 to 1.0) and displayed as percentages (0 to 100%).

5.8.4 LOAD CHAS.

The user may use Load CHAS under the Hazard command to load the results of a previous calculation into the active View. After selecting Load CHAS the user is presented with a file service screen that identifies nuclear (*.nuc), biological (*.bio) or chemical (*.chm) calculation files available to be loaded from the current directory. Select the desired directory, hazard type and hazard calculation. Provide a Theme name and a File name. The Theme name is that which will appear in the table of contents of the current View. The default Theme name is **Chas_YX:**, where Y represents the hazard type (N,B or C) and X represents a file index number, ranging from 01 to 99. The index number is assigned automatically, based on the lowest available number. The File name is assigned to the Shape File that contains all the information required to enter the calculation into the View. It is similarly indexed.

5.9 HPAC.

HPAC (Version 3.1 or 3.2) may be called from within CATS to perform calculations associated with release of toxic materials from nuclear, biological and chemical facilities and weapons. HPAC documentation is available separately from DTRA. Note that HPAC is also executed for chemical, biological and radiological releases, using the CATS Rapid Hazard Analysis capability described in section 5.1.

5.9.1 Running HPAC.

The hazard location must be entered manually in HPAC. Therefore, the user may wish to use the Hazard Origin tool in the View toolbar to select one or more event locations and record the selected latitudes and longitudes on a piece of paper before selecting ***Run HPAC*** under the Hazard menu, which executes **Pcscipuf.exe** located in the HPAC home directory specified in CATS Preferences/CATS System Settings (see section 3.1).

5.9.2 Importing HPAC Output

Upon completion of the HPAC calculation, the user is left in the HPAC plot package. The user may choose to preview HPAC result while still in the code. This will permit the user to review and, if necessary, edit the calculation by quitting the plot package, returning to the HPAC main screen, and reviewing or editing the input parameters. From the HPAC plot package the user has the following options for importing HPAC hazard data into CATS:

No Import: The user may choose to not import HPAC results or to defer such import to a later time. In this case the user should exit HPAC, whereupon the screen shown in Figure 69 will appear. Select No to return to the current view and proceed with the CATS session.

Import: The user may choose to import the hazard and expected mortality probability values from HPAC or use the HPAC plot package to display and export alternative quantities. These options are explained below. The explanation refers to version 3.1 of HPAC.

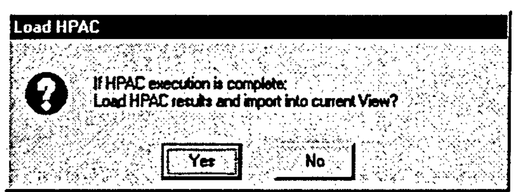


Figure 69. HPAC hazard import options.

Non-Conditional Gaussian Probability Import: The HPAC ground level output quantities imported into the CATS active View are as follows:

- Radiation dose and total effective dose equivalent (nuclear facilities and nuclear weapon fallout radiation)
- Chemical and biological dosage and deposition.

HPAC calculates the mean and the variance for time-integrated hazard quantities at each grid location, and the default HPAC plot package display is the mean value hazard distribution at ground level. However, the mean values may be misleading and are not recommended for use in assessing hazard extent or performing consequence assessment. Rather, CATS imports and displays HPAC output quantities as **Non-Conditional Gaussian Probability** distributions.

The default level of non-conditional Gaussian probability to be displayed in the CATS active view is set in User Preferences. The probability indicates the likelihood of a criterion reaching a given extent. For example, as illustrated in Figure 70, a low probability value would create a footprint having a larger extent than a high probability value. The default probability is initially set at one percent, which means that there is a 1% chance that the hazard will reach the limits shown for the given criterion level. Conversely, there is 99% confidence that the criterion hazard level will be contained within the limits shown. The non-conditional Gaussian probability used in CATS should be differentiated from the conditional Gaussian probability display used in the HPAC plot package. The HPAC conditional probability display indicates the probable level of hazard at each location on the condition that any hazard was present at that location.

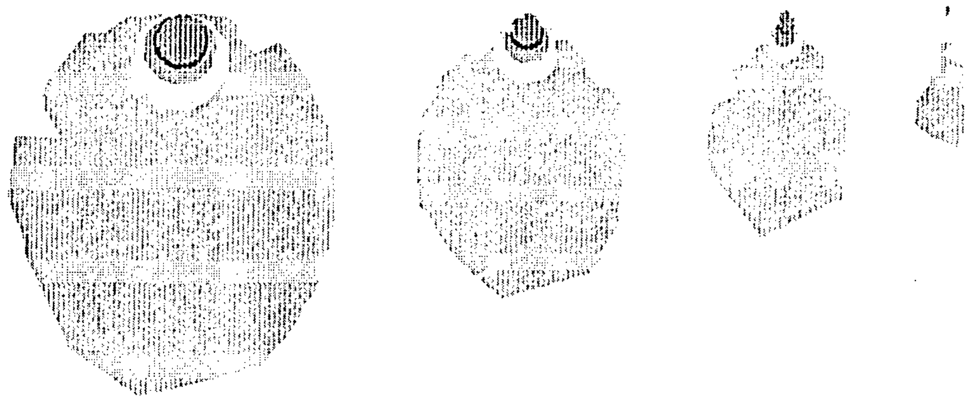


Figure 70. HPAC dosage at ground level, 1%, 10%, 25% and 50% non-conditional Gaussian probability representations of the same plume.

When the radiation results are loaded into the active view, a data set created using the RIPD code is used to calculate mortality probability appropriate to the selected exposure lapsed time. For lapsed time less than one hour, mortality criteria are the same as those for instantaneous exposure. For lapsed time greater than one hour exposure is assumed to begin at one hour.

When the chemical and biological results are loaded into the active View, the NewCas code also calculates the health effects associated with the dosage (biological agent) or dosage and deposition (chemical agent). These include:

- **Mortality** (biological and chemical),
- **Incapacitation** (biological and chemical),
- **Visual impairment** (chemical) and
- **Threshold** of onset for all symptoms (chemical).

These health effects calculations are made assuming no protection other than normal clothing and no medical treatment.

The effects probability distribution is depicted using the expected value at each calculated grid point. It is obtained by convoluting the non-conditional Gaussian hazard probability distribution with the cumulative effects probability distribution at a single grid point; the resulting local effects probability distribution is then integrated over all possible values of hazard level to obtain the expected effect probability at that point. This process is repeated for each grid point. Unlike the hazard level, the effects probability distribution has no associated uncertainty.

To import ground level hazard and effects quantities into CATS, exit HPAC and select *Yes* in the screen illustrated in Figure 69. A file service with then appear, as illustrated in Figure 71. Using the file service, select the name of the HPAC calculation to be imported; the file will have a *.prj extension.

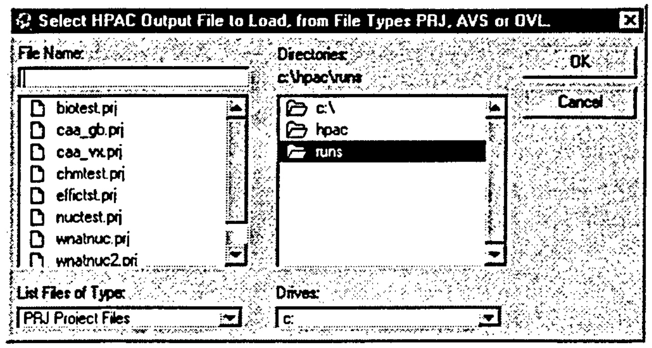


Figure 71. HPAC hazard import selection.

After selecting the HPAC *.prj file to import, CATS interrogates the file, determines the time steps for which calculations are available and presents these to the user, as illustrated in Figure 72. These time steps indicate the period over which chemical and biological dosage and deposition and radiation dose have been accumulated, relative to the beginning of the release even and, in the case of nuclear weapons fallout radiation, the times at which dose rates are available. The user may also select User-defined lapsed times for exposure to fallout radiation, in which case the user will be prompted to supply alternative times in units of days. Fractional days (to two decimal places) are allowed. If the User-defined time is less than the maximum time for which HPAC results are available on an individual basis, the results for the reported time closest to the User-defined time will be chosen.

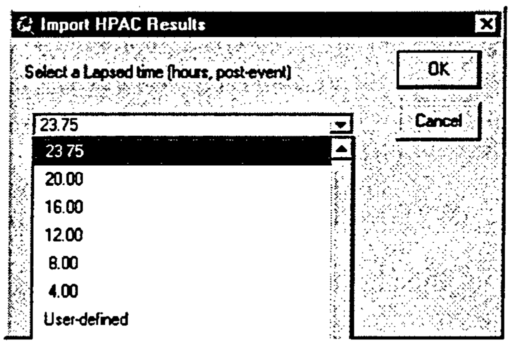


Figure 72. Select from available HPAC output times.

Note: Data for only a single output time are loaded for display and analysis in the active View, per import operation. However, the user may import data for as many of the available times as desired, using the LOAD HPAC command under Hazard.

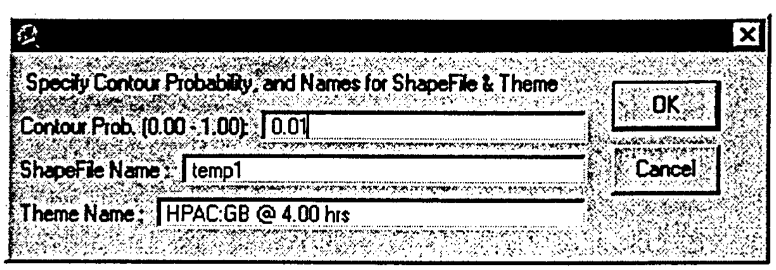


Figure 73. Specify ShapeFile Name and Theme Name.

As illustrated in Figure 73, after selecting the desired HPAC output time, the user may modify the level of non-conditional Gaussian probability associated with the hazard to be displayed. The user may also specify the base name of the ShapeFile containing the data displayed in the View; a separate ShapeFile for each theme is stored in the CATS Working Directory in a subdirectory, named "shapes." The default ShapeFile base name selection is the same as the HPAC output file. It is suggested that, whatever name is chosen, it be easy to reference back to the original HPAC run. Next, enter a Theme name, which is the title that will appear in the table of contents of the CATS View. The default gives the type of release event, the agent and the post-event duration. It is usually a good idea to enter additional information that will help identify the attributes of the calculation or the display, such as the probability associated with dosage and deposition.

Upon selection of the ShapeFile and Theme names, CATS will import hazards and, in the case of military biological and chemical agents, casualty probabilities into the current View. Each quantity derived from the HPAC output, i.e., dosage, deposition, mortality probability, etc., will have its own entry under the common Theme name. The ShapeFiles for these entries are made up of polygons created according to preset criteria and may not be re-contoured by the user.

Note: The ShapeFile name is assigned to the ShapeFile that contains all the information required to enter the calculation into the View. The ShapeFile contains everything required for display and analysis of HPAC data at a single lapsed time and does not refer back to the HPAC output files. Therefore, once the user is satisfied that all the relevant data have been loaded into a CATS View or otherwise converted to ShapeFile form, the large HPAC output files, particularly the *.dep and *.dos files may be archived or deleted from the CATS Working Directory, as desired.

HPAC Export File Import: As noted above, HPAC calculates the mean and the variance for time-integrated hazard quantities at each grid location. The HPAC Plot Package may be used to change the quantity displayed. It is possible to import into CATS custom quantities available for display in HPAC, as follows:

Mean Value - surface dosage (dose), surface deposition (dose rate), Latitude and Longitude projection This is the same quantity that may be imported using *.prj files, as discussed above.
Probability (P[V>E]) - surface dosage (dose), surface deposition (dose rate), Latitude and Longitude projection. This is the spatial distribution of the probability of the hazard exceeding some criterion value.
Exceed. (V[Pc>P]) - surface dosage (dose), surface deposition (dose rate), Latitude and Longitude projection.

Plot type three represents the spatial distribution of the hazard at a specified probability criterion level. It is conditional in that it is limited to non-zero values of the hazard and may be interpreted as the minimum level of hazard distribution associated with a specified probability (level of confidence), provided that some hazard was present. Note that it does not tell the user the extent of the hazard with a given probability.

The user should choose options in the HPAC Plot Package and prepare the desired hazard representation. After this preparation the user should use the Export option under Plot Control in the HPAC Plot Package to create a file containing the desired information. Export options that may be used for import into CATS are *.AVS and *.OVL.

After preparing the hazard representation in the HPAC Plot Package, the user should do the following before exporting to a file:

First, zoom to the maximum extent of the visible hazard; this will prevent inadvertent truncation of the hazard and will minimize zero values in the file,

Second, choose Maps under Plot Options and enter a non-zero value in the Population Density edit box; this causes HPAC to export the hazard at the highest level of spatial detail calculated, otherwise the grid resolution of the exported hazard will be a function of the degree of magnification in the HPAC display. After making these changes, **re-Draw**, and

Third, there is some information added in the process of creating the HPAC export file that is not accessible to CATS when importing that file, such information includes the name of the project from which the export file was derived, the post-event time and the probability or hazard criterion. Therefore, the user should make a note of these items before exiting HPAC and keep them for use in the export process.

Fourth, use the HPAC Export command to create *.AVS or *.OVL files.

- ***.AVS Files**: This file type contains hazard information at grid points, either in terms of level or probability. Use this file type to export hazard information that may be re-contoured in CATS if desired, and in the case of hazard distributions (mean or conditional probability) may be used to compute casualty probabilities.
- ***.OVL Files:** This file type contains contour information only, not gridded data. Use this file type to export hazard information so that it will appear exactly as it did in the HPAC plot package.

Note: When exporting a file, choose a name that can easily be related back to the name of the HPAC project file (*.prj) from which it is derived, as the user will be asked for the name of the project file when importing the HPAC Export file into CATS.

After exporting an HPAC plot file, exit HPAC, choose Yes in the HPAC import options screen, as illustrated in Figure 5-69. In the file service screen, as illustrated in Figure 70, first select the type of export file to be imported, *.AVS or .OVL. Next, select the file to be imported into CATS. In the case of *.AVS files, the user will be asked whether the chosen file has the same base name as the HPAC project file from which it was derived, as illustrated in Figure 74. If the answer is no, as is usually the case, the user will be referred to a file service screen to find and select the appropriate HPAC project file (.prj). After the appropriate project file name has been identified or if the base name of that file and the exported file are the same, the user is asked to provide a ShapeFile name and a Theme name, as illustrated in Figure 73. The default ShapeFile name is the same as the export file name; the default Theme name is derived from information contained in the associated project file, and typically includes the type of event and the name of the agent. However, it is advisable to add some information to the Theme name, such as post-event time or probability/dose criterion. The hazard information footprint imported into CATS should be the same as that created in HPAC.

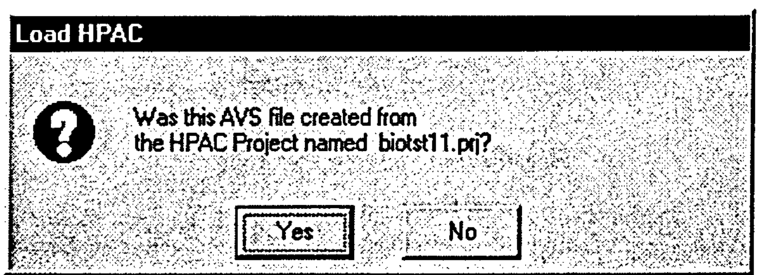


Figure 74. Export file origin query.

5.9.3 LOAD HPAC.

The user may use Load HPAC under the Hazard command to load the results of a previous calculation into the active View. After selecting Load HPAC and confirming the desire to load previously run HPAC files into the current view, the user will proceed through the same procedures as described in Section 5.10.2, above. These procedures allow the user to import HPAC results from project files (*.prj), including casualty assessment calculations for military chemical and biological agents, and exported files (*.avs and *.ovl), containing probabilistic information on hazard level and extent.

Note: Previous calculations include those run using the CATS Rapid Hazard Analysis option. The HPAC project file for such calculations has the name HPACTMP.PRJ and is located in the current working directory. This file is over written each time a new Rapid Hazard Analysis calculation in performed.

5.10 OSSM OIL SPILL.

The On-Scene Spill Model, Version 9 (OSSM) is an environmental simulation system designed for the rapid modeling of pollutant trajectories in the marine environment. The model has been integrated into CATS to simulate a limited number of pollutants. These include; gasoline, kerosene, jet fuel, diesel, and light, medium and heavy crude.

The **Run OSSM Oil Spill** selection under the Hazard drop down menu will open the OSSM Tool Box GUI. The tool box walks the user through each stage of the simulation process by progressively enabling only suitable functions. The tool box functions are designed in a sequential approach, as illustrated in Figure 75.

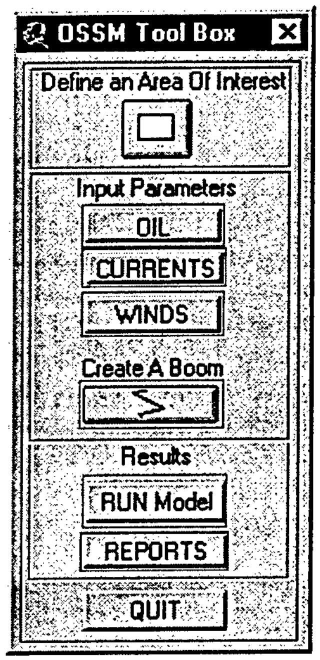


Figure 75. OSSM Tool Box.

Beginning at the top of the GUI, the user first defines an area of interest on the map display. This is accomplished by selecting the ***Define an Area of Interest*** (AOI) button in the tool box and drawing a rectangle in the map display window. An AOI is initiated by placing the cursor on the map display window. While holding down the left button on the mouse control, drag the cursor across the window until a graphic box encompasses the entire user desired area of study. The resulting themes labeled "OSSM: AOI" and "OSSM: GRID" are automatically loaded in the table of contents. The OSSM: GRID legend has "Land" and "Water" symbolized appropriately. By default, the OSSM: GRID theme is turned off, but can be turned on by checking the box in front of the theme. Due to the models' fixed resolution requirement, the land-water features in the OSSM: GRID theme will appear "blocky" and the themes' extent may be slightly longer or taller.

In specifying the area of interest consider that the OSSM does differentiate between ice and water. Therefore, oil migration is not stopped by ice region boundaries. Also, OSSM is based on a 80 (East-West) by 48 (North-South) grid. If land features, such as islands or peninsulas are small compared to the size of a grid they may not be recognized by the model.

Upon loading of the OSSM: GRID theme into the view, the first of three required input parameters becomes enabled in the OSSM Tool Box. Selecting the ***Oil*** button initiates an "Oil Spill Input" window at the top left corner of the display as shown in Figure 76.

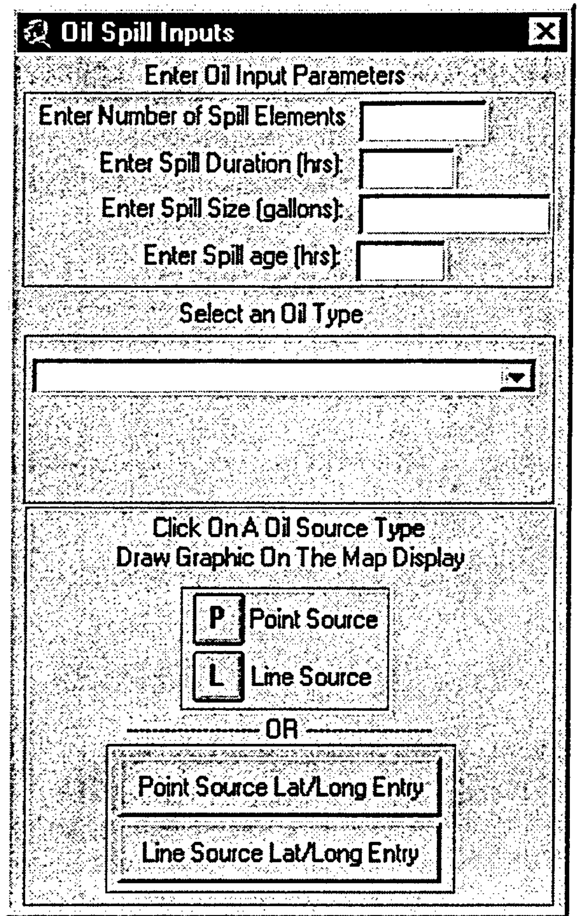


Figure 76. Oil Spill Input Window.

In the Oil Spill Input window, first enter each of the four descriptive oil input parameters;

- Number of "spill elements",
- "Spill duration" (in hours),
- "Size of the spill" (in gallons),
- "Age of the spill" (in hours).

The spilled pollutant is modeled as a collection of points, known as spill elements. Any actual quantity of spilled pollutant may be assigned to each element. It is convenient choose a number of spill elements that allows for easy convertibility between the quantity of spill elements and the quantity of the spilled substance. For example, applying a spill element value of 1,000 in a 10,000 gallon spill indicates that each discrete cell in the spill contains 10 gallons of pollutant. However, the amount of spill represented by a single cell should be kept small (~10 gallons or less) in order to create an accurate spill extent.

The "spill duration" field represents the elapsed spill release time. A "0" or "blank" value entered will stipulate that all the pollutant will be spilled immediately.

The "size of the spill" value characterizes the total quantity of spilled substance.

The "age of the spill" is the age in hours of the spill element at its release time (0 hours if just spilled) or its probable age at its sighting (value > 0). If the pollutant were released two days before it is sighted, its age would be 48 hours. Age is important because it influences the probability that the spill element will decay or evaporate in a given time step. For example, approximately half of freshly spilled gasoline will completely evaporate in one hour. If the age of some spilled gasoline is 24 hours, it is almost certain that none of it will evaporate in the first hour of running the model. The period of high probability of evaporation has already occurred.

Next, select the desired type of oil from the drop down menu list as illustrated in Figure 77. The OSSM model can simulate gasoline, kerosene, jet fuel, diesel as well as light, medium or heavy crude.

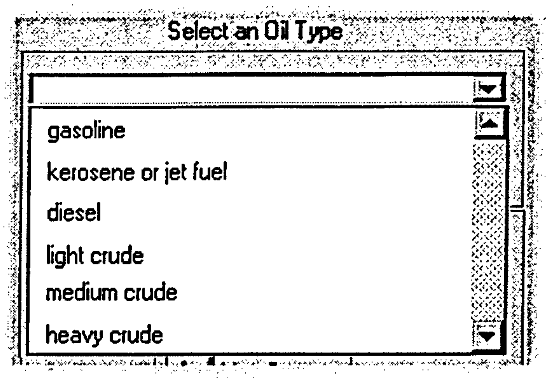


Figure 77. Oil Type Selection List.

Finally, the user must define the source location of the spill. Either a "point" or a "line" source may be simulated. A point source spill location is one in which the spill originates from a single location. A spill from a stationary oil platform is one such example. A line source location is one where the spills' source continually shifts location throughout the duration of the spill. Discharge from a traversing oil tanker could be one such line source example.

Either point or line source locations may be defined graphically on the map display. A point source location is created by clicking the ***P*** Point source button in the Oil Spill Input window and then clicking (left mouse control) the appropriate location on the map display. A black dot is drawn on the map display indicating the user's point source location. Similarly, a line source location is created by clicking the ***L*** Line source button in the Oil Spill Input window and then position the mouse at the start location on the map display. Hold down the left mouse control button to anchor the beginning of the line and move the mouse to the end of the line source location. Releasing the mouse control will anchor the end point of the line. A black line is illustrated on the map display signifying the delineated line source location. Both the graphic point and line source location processes may be repeated until the user is satisfied with the final input location.

Precise "point" source locations may also be typed directly into the model. This process is initiated by selecting the ***Point Source Lat/Long Entry*** button located near the bottom of the Oil Spill Input window. An Oil Spill Point Source Lat/Long Input window will emerge as shown in Figure 78. Enter the latitude and longitude in decimal degree format and click ***OK*** to complete the manual point source entry process.

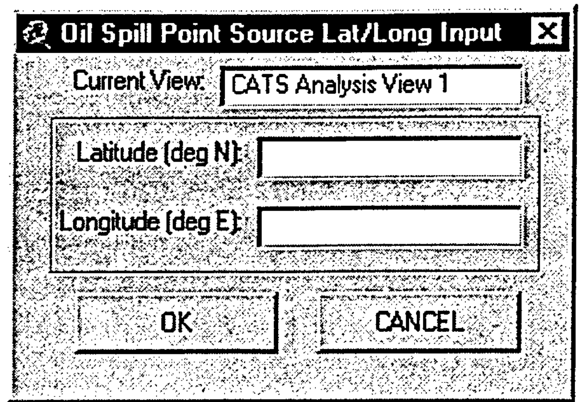


Figure 78. Manual Point Source Entry Window.

Precise "line" source spill locations may be entered through the keyboard as well. Initiate this process by selecting the ***Line Source Lat/Long Entry*** button located at the bottom of the Oil Spill Input window. An Oil Spill Line Source Lat/Long Input window will emerge as shown in Figure 79. Enter the latitude and longitude in decimal degree format for the beginning and ending nodes of the spill line source. Then click ***OK*** to complete the manual line source entry process.

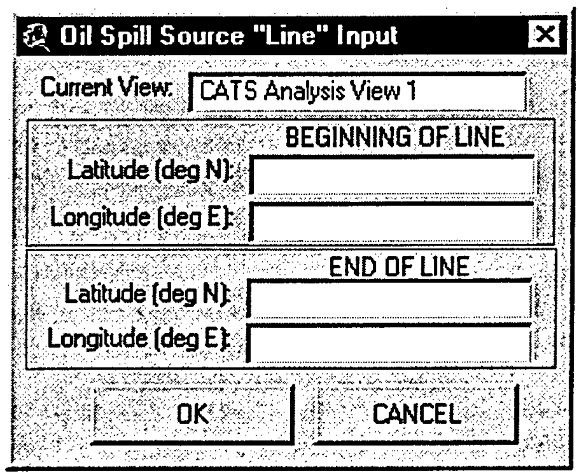


Figure 79. Manual Line Source Entry Window.

Upon completion of the descriptive oil parameters, the ***CURRENTS*** button on the Oil Spill Tool Box becomes enabled, refer to Figure 75 for illustration. Click on the ***CURRENTS*** to initiate the "Create Currents Input File" window as shown in Figure 80.

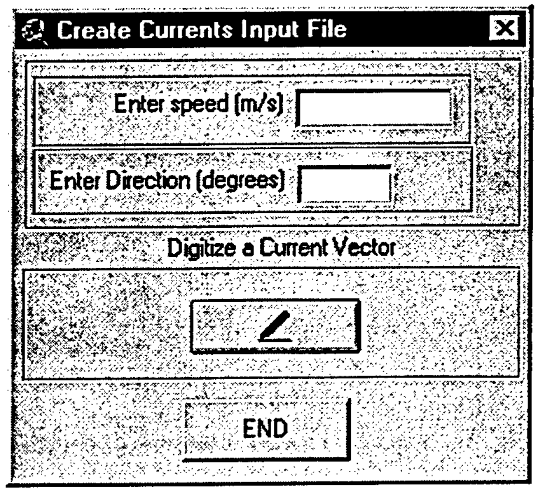


Figure 80. Currents Data Entry Window.

There are two required data entry fields in this window:

- Speed of the current(s)
- Direction of the current(s)

The current speed must be specified in terms of meters per second. Values less than 1 must be preceded by a zero and a decimal. The current direction (direction toward which the current is flowing) is specified in terms of degrees on a compass (0-360). For example, 0 or 360 correlate to a northerly flow direction, 90 east, 180 south and 270 west. After the current speed and direction parameters are entered, click on the ***Digitize a Current Vector*** button on the Create Currents Input File window and click the current location on the map display. A red arrow will be drawn on the display indicating the user defined current vector. Multiple current vectors may be added in this process, before executing an OSSM calculation. The OSSM Model creates a current velocity grid from the user specified current vectors. Select the ***END*** button to terminate the current input process. Please note that the ***Digitize a Current Vector*** button is disabled if either the current "speed" or "direction" fields are empty.

Upon completion of the current factors, the ***WINDS*** button on the Oil Spill Tool Box becomes enabled, refer to Figure 75 for illustration. Click on the ***WINDS*** to initiate the "Create Wind Input File" window as shown in Figure 81.

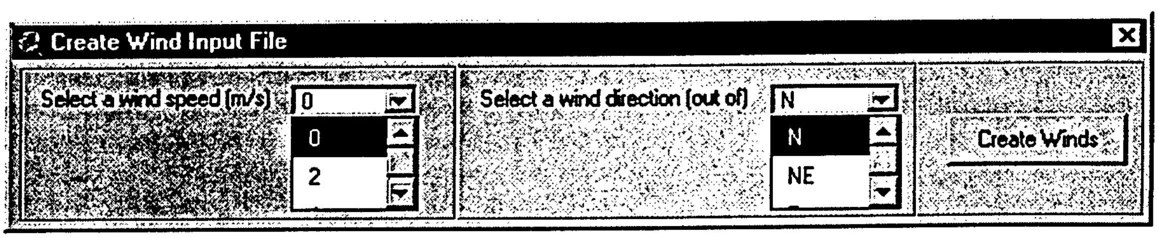


Figure 81. Wind Data Entry Window.

Select a wind speed and wind direction (direction from which the wind is blowing) from their respective pull down menus. A wind speed may range from 0 to 16 meters per second, where a 0 value indicates a calm wind. The wind direction choices are "out of the"; "N" (north), "NE" (northeast), "E" (east), "S" (south), "SE" (southeast), "SW" (southwest), "W" (west) and "NW" (northwest). The resulting wind field is draped over the entire user defined area of interest.

The OSSM model is now ready to run. Any input parameter can be altered by returning to the tool box and selecting the appropriate tool before or after running the model. A user defined "Boom" may also be added to the model any time after the area of interest grid is created. A boom is added by selecting the ***Create a Boom*** button in the OSSM Tool Box window and then position the mouse on the map display. Click the left mouse control to anchor each boom vertex. Double click the left mouse to end adding a boom. The previous "area of interest" (OSSM: GRID) is replaced with one that includes the user-defined boom, i.e. ground replaces water at grid locations specified for the boom, preventing oil from passing through those grid locations.

Select the ***RUN*** button in the "OSSM Tool Box" to run the model. The model simulates the spill over a period of two days (48 hours). The model spatial output results are based on six-hour time slices of the simulation. Consequently, a maximum of eight themes may be automatically loaded into the user's current view. Each output theme represents the density of spill substance at the end of its distinct time period. For example, the first theme loaded will be the density of the spill substance at the end of six hours of simulation. The last output theme loaded will be the density of the spill substance after 48 hours. Spill density is categorized as "Low" (0.1 – 26.42 gal/km^2), "Medium" (26.43 – 104.8 gal/km^2) and "High" (104.9 - 1000000 gal/km^2). This is based on the oil spill observation glossary published by NOAA. The banner illustrated in Figure 82 will be displayed on the screen for 5 seconds after the last model result is loaded.

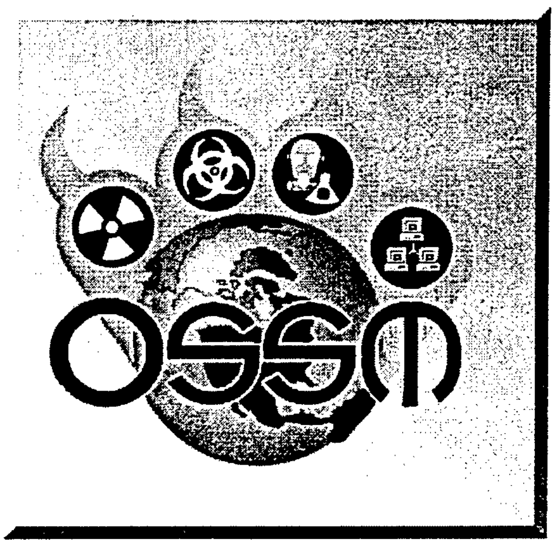


Figure 82. Model Result "Complete" Banner.

Results from a spill simulation may yield less than eight output time slice themes. The exact number of output themes loaded into the view is dependent upon the user defined input values. An output theme will not be loaded in the view if the result of the analysis is empty. An empty result theme may be due to spill substance evaporation or the resulting spill substance is outside the user-defined area of interest. Running the ***REPORTS*** from the "OSSM Tool Box" will show the percent of spill evaporation and the percent spill substance that is outside the area of interest, regardless if the output theme was loaded in the view or not. See the next section for a detailed description of the "Report" function. Consequently, the "Report" function will clarify why less than eight themes may be loaded in the view after a spill simulation has completed.

Running the ***REPORTS*** from the "OSSM Tool Box" will exhibit some basic statistical analysis for all eight resulting time slices as displayed in Figure 83. The statistical categories include; "Time Period", "% Evaporation", "%Beached", "% Off AOI" and "% At Sea". The "Time Period' refers to each slice in time from 6 to 48 hours of the simulation, regardless if the output theme was loaded in the view or not. The "% Evaporation" refers to the amount of spill substance evaporated at the end of each time period. The "% Beached" refers to the amount of spill substance that has been beached on land or on a user defined boom. The "% Off AOI" refers to the amount of spill substance that is outside the user-defined area of interest. Any spill substance outside the area

of interest will not be visible on the map display. Finally, the "% At Sea" refers to the amount of spill substance still floating on the surface. The user-defined "Spill Duration" input value directly effects this statistic.

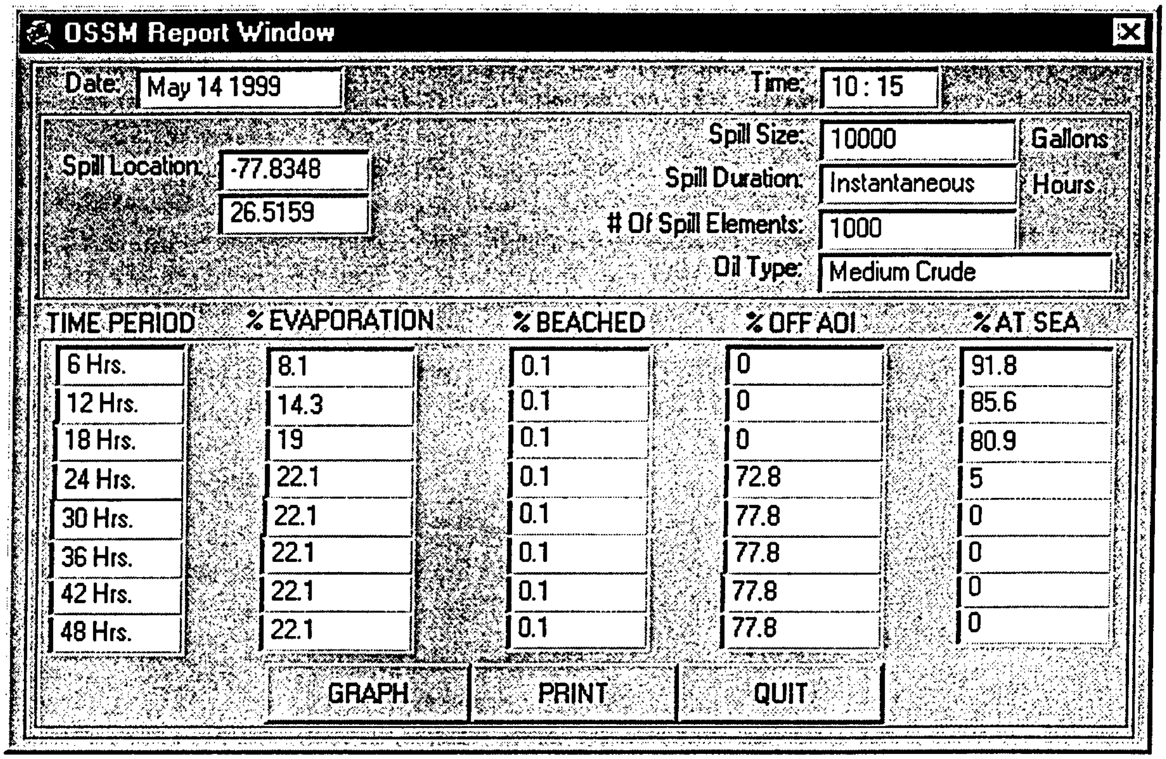


Figure 83. OSSM Report Window.

The report window also displays user-defined input values that were used to simulate the spill. These values include; the spill size, spill duration, the number of spill elements, the type of spill substance used and the spill source location.

The report can also be examined in graphical format as well as a statistical report. Selecting the ***GRAPH*** button located on the bottom left corner of the Report Window will create a graph of the report. Figure 84 illustrates a typical summary report column graph.

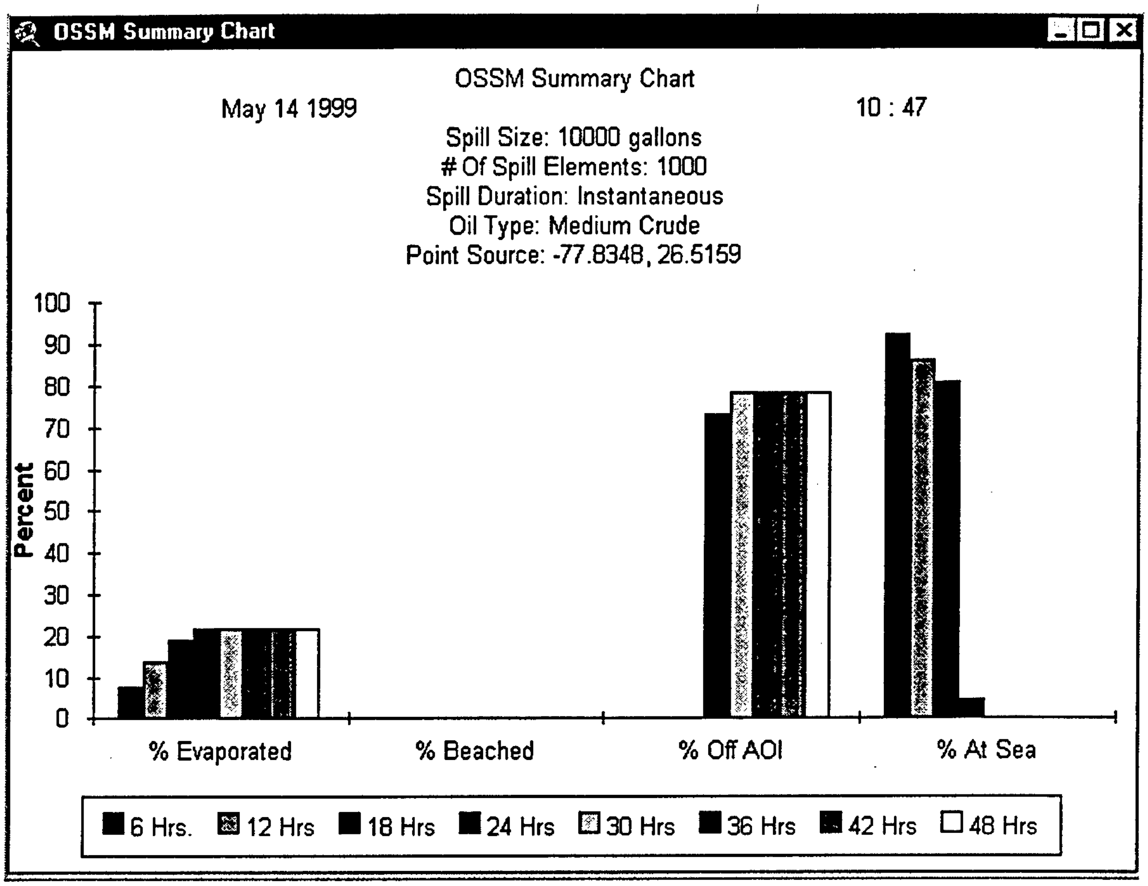


Figure 84. OSSM Summary Chart.

The summary chart illustrates a "side-by-side" temporal comparison for each statistical category (% Evaporated, % Beached, % Off AOI and % At Sea). Exercising this type of graph may facilitate observation of changes between time slices when analyzing each category.

Several custom buttons and tools have been developed to facilitate navigation between the report window and the various chart windows. These functions are illustrated in Figure 85.

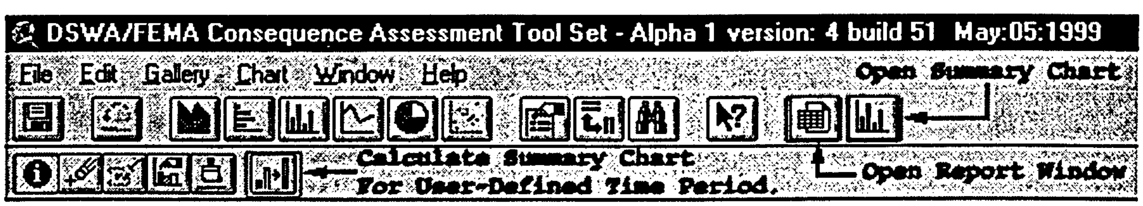


Figure 85. Custom Chart Buttons and Tools.

The custom chart buttons/tools are described below;

Open Report Window button. This button is available when either the "OSSM Summary Chart" or the "OSSM Summary Time Period Chart" is active. The button, when selected, will re-open the "Report Window".

Open Summary Chart button . This button is available when the "OSSM Summary Time Period Chart" is active. The button, when selected, will re-open the "OSSM Summary Chart".

Calculate Summary Chart For User-Defined Time Period tool . This tool is available when the "OSSM Summary Chart" is active. This tool creates a column bar graph of the user-selected time period. This is accomplished by first clicking on the tool and then clicking on any of the columns in the "OSSM Summary Chart". The ensuing chart will exhibit the %; Evaporated, Beached, Off the AOI and At Sea for the user-selected time period. An example of the OSSM Summary Time Period Chart is illustrated in Figure 86.

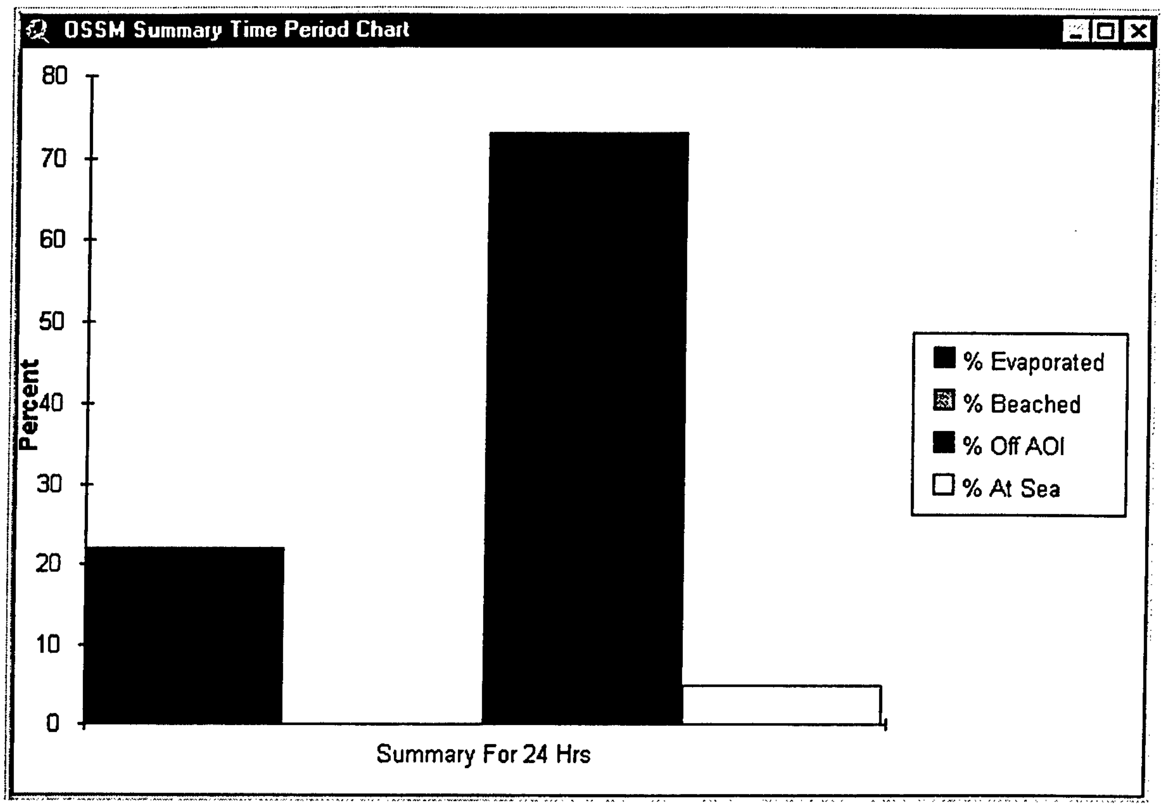


Figure 86. OSSM Summary Time Period Chart.

A hardcopy of the spill substance and/or the summary report may also be easily generated from the OSSM Report Window (see Figure 81). Selecting the ***PRINT*** button in the window will initiate the "OSSM Print Report Setup" window (illustrated in Figure 87).

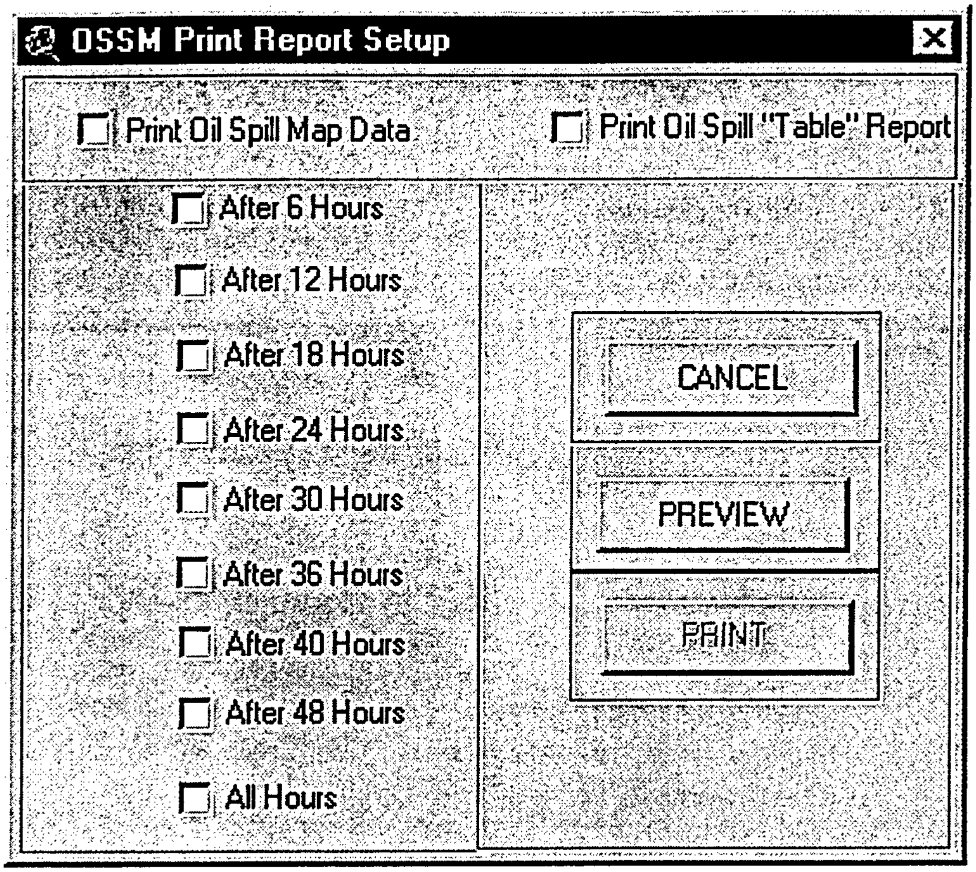


Figure 87. OSSM Print Report Setup.

Two options are available at the top of the window:

- Print Oil Spill Map Data: Check this box to include the spatial map data.
- Print Oil Spill "Table" Report: Check this box to include the table report.

The ***PREVIEW*** button displays an illustration of the hardcopy output to the screen. An example of the output preview illustration is found in Figure 88.

The ***PRINT*** button will send the print file to the "default" printer. Holding down the shift key & selecting the ***PRINT*** button at the same time will allow the user to change the default printer.

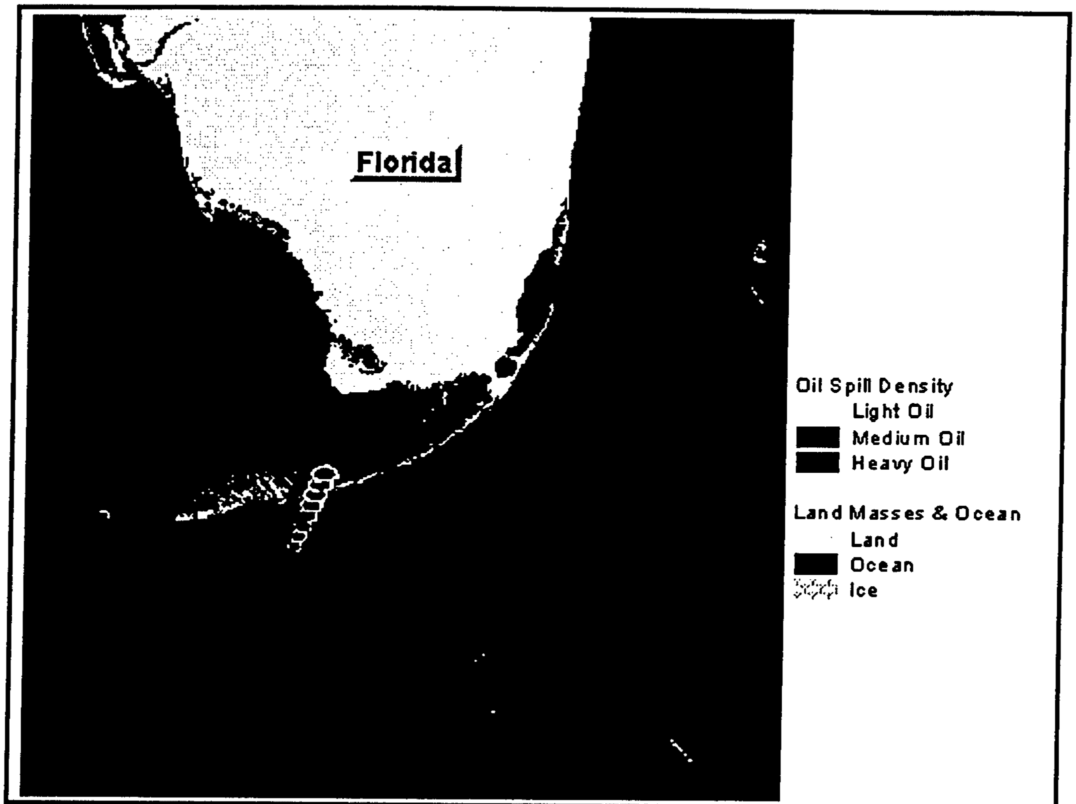
Input parameters may be changed at any time and simulations quickly re-run. The "OSSM Tool Box" can be opened with all of its functions enabled by holding down the shift key at the same time selecting ***Run OSSM Oil Spill*** from the **Hazard** pull down menu. Note that after a run, new wind and current entries replace the existing entries. However, the graphics of the old entries remain and must be manually removed. Highlight the graphic using the Pointer tool (hold down the shift key to highlight multiple graphic objects) and then select the ***Delete Graphics*** command from the **Edit** menu.

OSSM Oil Spill Analysis

Date: May 25 1999 Time: 3 : 55

Spill Size: 10000 gallons
Of Spill Elements: 1000
Point Source: -81.3047, 24.3874

Spill Duration: Instantaneous
Oil Type: Medium Crude



Time Period	% Evaporated	% Beached	% Off AOI	% At Sea
6 Hrs.	7	0	0	93
12 Hrs.	13	0	0	87
18 Hrs.	17	0	0	83
24 Hrs.	21	0	0	79
30 Hrs.	25	0	0	75
36 Hrs.	27	0	0	73
42 Hrs.	29	0	0	71
48 Hrs.	30	0	0	70

Figure 88. Preview Print Example.

SECTION 6

NATURAL HAZARDS

In addition to simulating effects from technological hazards, CATS also contains applications for calculating the spatial damage distributions and assessment of casualties from the following natural hazard phenomena:

- **Hurricane**, which calculates structural damage from winds;
- **Hurricane Uncertainty**, which refers to the possible spread of hurricane damage based on the uncertainty in the hurricane track forecasts;
- **Storm Surge**, which calculates coastal flooding due to the combination of hurricane winds and tides;
- **NHC Surge**, which loads the results of Storm Surge analysis published by the National Hurricane Center;
- **Earthquake**, which calculates structural damage due to ground shaking.

Section 6.1 addresses the workings of the CATS Hurricane Model, Section 6.2 the Hurricane Uncertainty Model, Section 6.3 discusses the Hurricane Storm Surge Model, Section 6.4 describes the NHC Surge Model, and Section 6.5 the Earthquake Model. Each of these sections is divided into three basic subsections: the first subsection provides a short introductory narrative to the model being discussed, the second describes how to execute it step by step, and the third illustrates how to view and analyze its output. An Appendix that provides detailed descriptions of the Hurricane Model and its related phenomena (Hurricanes, Surge, Hurricane Uncertainty, and Weather Sources) is located at the end of this document.

The first step involved in executing any of these models is to launch the CATS application. Once this is done, the next step is to create a CATS scenario by choosing the ***CATS Menu*** selection option, then ***Create CATS Scenario***. (Please review Figures 15 and 16). A viewscreen will be created like that shown previously in Figure 21, containing the CATS themes of interest such as maps, rivers, roads, population, etc. The following section discusses how to run the CATS Hurricane Model, assuming that a CATS scenario has been created.

6.1 HURRICANE.

6.1.1 Introduction.

The Hurricane Model resident in the Natural Hazards portion of CATS consists of a Hurricane Tracking Module, a Wind Damage Estimation Module, and a Geographic Information System. These three utilities combine to determine and display the current and forecast paths of the storm, areas of projected structural damage, and the number of persons at risk. The Model was developed to provide emergency managers with a real-time estimate of civil resources and population at risk from threatening tropical storms, and uses hurricane observation and forecast data provided by a variety of weather services. It incorporates accepted structural response modeling techniques to determine susceptibility of a wide selection of residential and infrastructure types to the dynamic pressure resulting from hurricane winds. It has successfully demonstrated a capability to provide rapid, accurate guidance to FEMA for providing an effective response to natural disasters since the beginning of the 1993 Atlantic hurricane season. Detailed discussions of the components of the model are provided in Appendix A, Sections 1 and 2.

6.1.2 Hurricane Model Execution.

To run the hurricane model, proceed as follows. After the CATS application has been launched and a CATS Scenario has been created, a relief map of the Continental United States (CONUS) appears in the *CATS Analysis View 1* window. The first step in running the Hurricane model is to select ***Run Hurricane*** from the Hazards pull-down menu, as illustrated in Figure 89. This action will then open the window shown in Figure 90, listing the advisory messages available from the various hurricane forecasts.

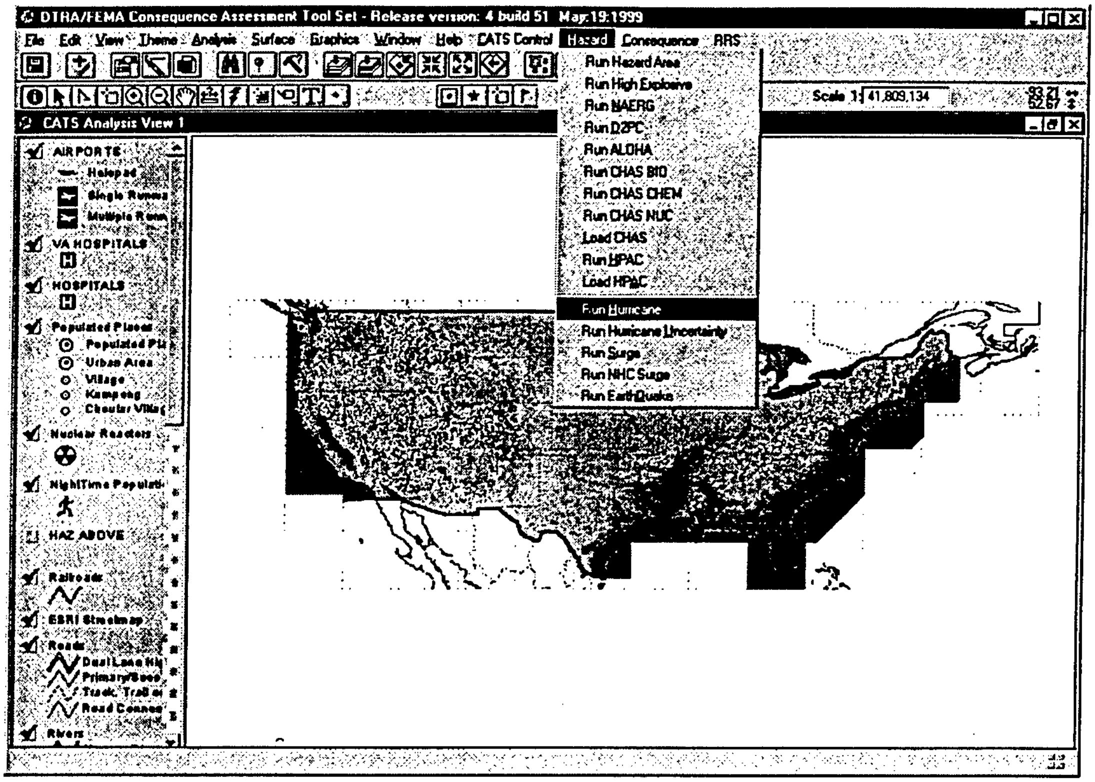


Figure 89. Select *Run Hurricane* from the Hazard Menu.

These advisories contain data necessary for model execution, such as current and forecast positions of the storm, its maximum wind speed, and the distribution of wind speeds around the storm. Advisories can be obtained via a variety of methods, including the World Wide Web, e-mail, and commercial vendors. These methods are discussed in detail in Appendix A, Section 5. Once obtained, message files must be placed in the D:\cats\cats_rlt\huradv directory (assuming CATS was installed on the D drive; otherwise substitute your own installation drive in the pathname). A set of sample hurricane advisories is provided in CATS for various hurricanes. Select the desired advisory message as shown in Figure 90 (Emily 36, for example; the 36th in the series of Emily advisories) and click on ***OK***.

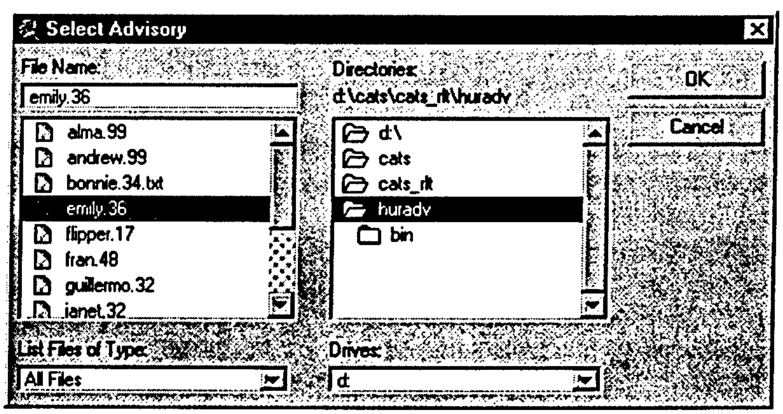


Figure 90. Select Advisory Message for Model Input.

The system will take a few seconds to parse the message, retrieve the necessary forecast data, and input this data into the model. The windows shown in Figure 91 will appear, providing information as to the status of the model's execution. Depending on operating system in use, the user may need to close the "Finished-go" window manually to continue with the program.

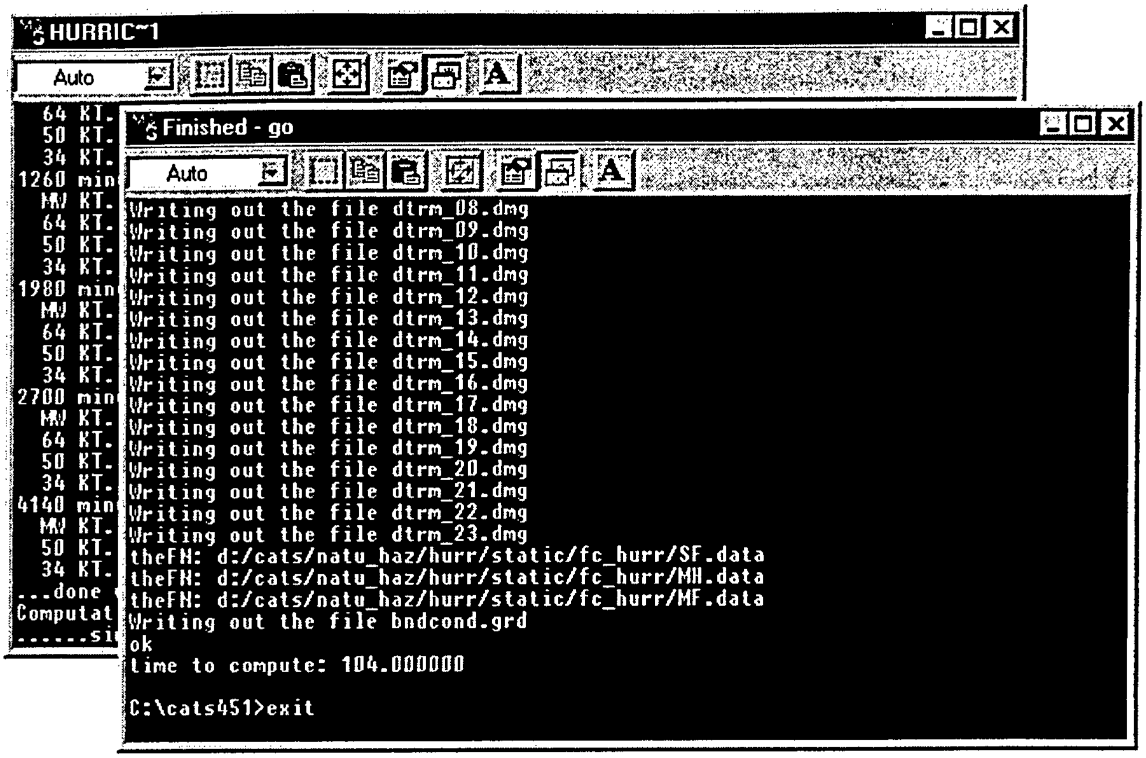


Figure 91. Window Display.

Next, the hurricane wind damage is calculated. There are twenty-three structures for which damage can be computed. Probabilistic wind damage is computed for the three residential structure types: mobile homes, single family homes and multifamily homes. Deterministic damage is computed for all twenty-three structure types. Probabilistic and deterministic damage are described as follows:

Probabilistic: Computes the spatial distribution of the *probability* that a specific level of damage *(light, moderate*, or *severe)* will occur for a specific structure type.

Deterministic: Determines the expected (average) spatial distribution of the levels of damage *(light, moderate*, or *severe)* for a specific structure type.

- ***Light*** damage causes minor inconvenience to the resident but does not impact structural integrity.

- ***Moderate*** damage may include damage to roofs, structure interior, and structure frame; structural integrity is not compromised, though, and the structure would eventually be suitable for residential use.

- ***Severe*** damage includes manifestations of moderate damage, but also compromises structural integrity, leaving the structure permanently uninhabitable. Probabilistic and deterministic damage calculations are based on hurricane dynamic pressure (related to hurricane wind speed) and structure type.

After the model run is finished, a window will open asking the user whether all structure damage should be loaded, or whether only residential damage should be loaded (as this example indicates). This prompt is shown in Figure 92. Control returns to the scenario from which the calculation was launched.

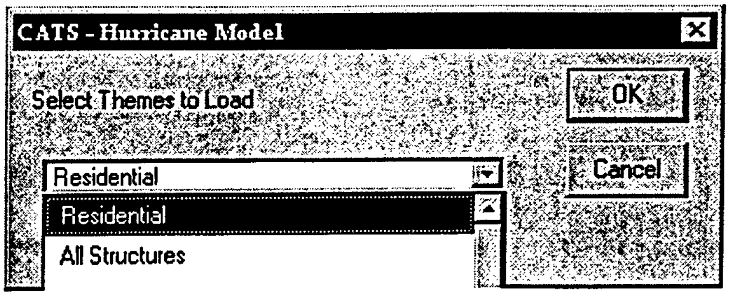


Figure 92. Load Themes GUI.

6.1.3 Situation Display.

6.1.3.1 Viewing Probabilistic Severe Damage Bands.

The next step is to view the model output as shown in Figure 93. First, note that several new themes are present in the left-hand column of the viewscreen: the hurricane "track", and in this case, six sets of damage bands, one for each structure type loaded. Second, note that the hurricane track is checked "on" and is visible on the map. The track shows the current and forecast positions of the hurricane based on data parsed from the selected advisory message. To view the damage bands (for example, Emily-36-MH-Probabilistic, signifying Mobile Homes Probabilistic Damage), turn on this theme by clicking on the theme check-box so that a checkmark becomes visible. The screen displays, by default, probabilistic *severe* damage bands calculated by the model, as shown in Figure 93. (Viewing probabilistic *light* and *moderate* damage bands is discussed in Section 6.1.3.3.) Probabilistic *Severe* Damage to Mobile Homes is displayed in this figure, where the colors correspond to severe damage probability ranges: Green = <25% severe damage probability; Light Blue = 25-50%; Yellow = 50-75%, and Red = >75%. *(Light* and *Moderate* probabilistic damage displays will be discussed later.)

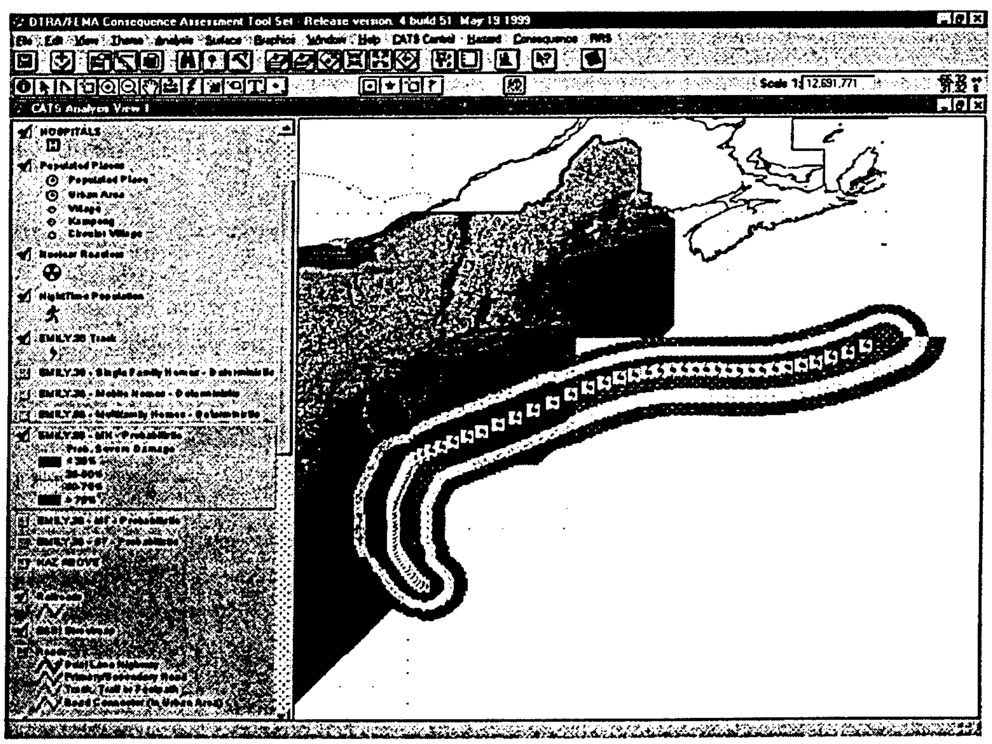


Figure 93. Hurricane Emily Track and Damage Bands.

The user can obtain detailed information in desired damage areas. First, zoom in by clicking (the ***Zoom-in*** tool) and by drawing a box around a selected area of interest, such as the coast of North Carolina. This will enable the user to visually "blow up" an area and allow for study of highly gee-specific selections. Next, click on the

Identify tool and then click within a damage band color. An "Identify Results" box will appear, displaying probabilities of light, moderate, and severe damage at the specific point selected. Sample results of *carrying* out these directives are shown in Figure 94. The damage probability breakdown sums to 100 percent.

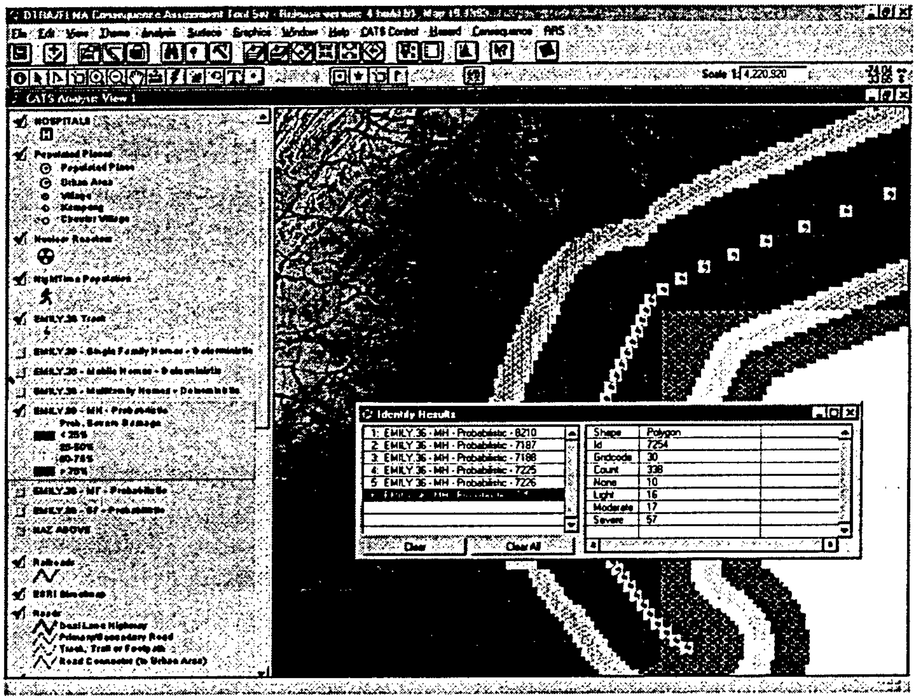
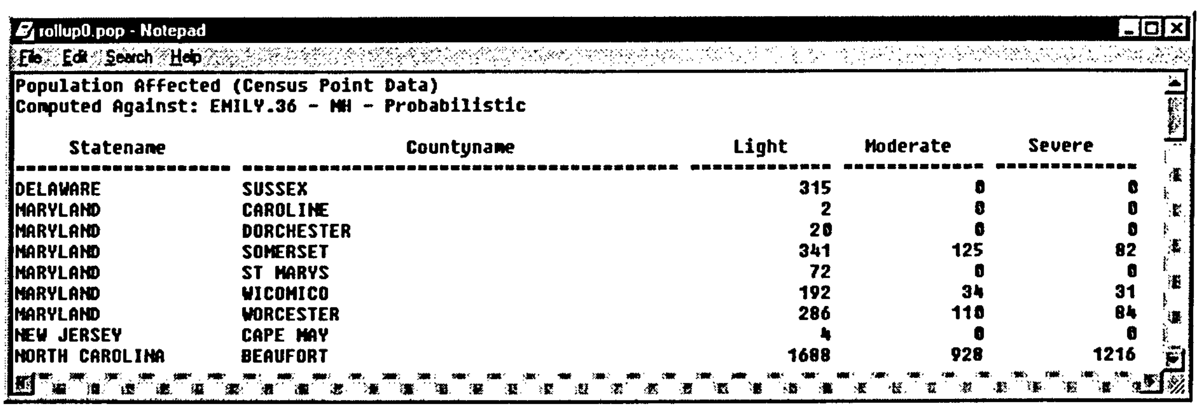


Figure 94. Damage-Band Zoom-in and 'Identify Results' Utility.

6.1.3.2 Population "Roll-Up" (Probabilistic Damage).

To calculate the number of persons at risk who live in a certain structure type, one first selects the desired theme (for example, MH-Probabilistic), then selects the ***Consequence*** menu, ***Pop Effects,*** and, finally, ***1990 Census (State/County) Point*** or ***1990 Census (Cong. Dist.) Point***. Based on the damage probability distributions, the number of persons residing in the given structure (from point population data) expected to experience light, moderate, and severe damage will be determined and displayed. An example of the results of such a "Roll-Up" for Hurricane damage to mobile homes is shown in Figure 95.



rollup0.pop - Notepad

File Edit Search Help

Population Affected (Census Point Data)
Computed Against: EMILY.36 - MH - Probabilistic

Statename	Countyname	Light	Moderate	Severe
DELAWARE	SUSSEX	315	0	0
MARYLAND	CAROLINE	2	0	0
MARYLAND	DORCHESTER	20	0	0
MARYLAND	SOMERSET	341	125	82
MARYLAND	ST MARYS	72	0	0
MARYLAND	WICOMICO	192	34	31
MARYLAND	WORCESTER	286	110	84
NEW JERSEY	CAPE MAY	4	0	0
NORTH CAROLINA	BEAUFORT	1688	928	1216

Figure 95. Expected Numbers of Persons at Risk from Mobile Home Damage.

6.1.3.3 Viewing Additional Levels of Probabilistic Damage Bands (Light and Moderate).

Recall that Figures 93 and 94 display *severe* probabilistic damage bands resulting from a Hurricane Model run. Two other categories of damage exist, *light* and *moderate.* To view probabilistic damage associated with either of these categories, additional Steps must be taken:

- Double click on the desired damage theme, e.g., "EMILY.36 - MH - Probabilistic". The "Legend Editor" window shown in Figure 96 will appear.

- Click on the ***Load*** button to load the required Hurricane Damage Legend off the hard disk, as shown in Figure 96. The name of the legend is *hurrprob.avl;* the full pathname that must be navigated to is (assuming CATS was installed on the D drive) *D:\cats\natu_haz\hurr\avl\hunprob.avl,* as the figure illustrates. (Substitute your own CATS drive in the path.) Once the legend is selected, press ***OK.***

- The window in Figure 96 appears. Next to the text label "Field", select the desired damage level to be viewed, e.g., *Moderate.* Make sure the "All" box is checked, then click ***OK.***

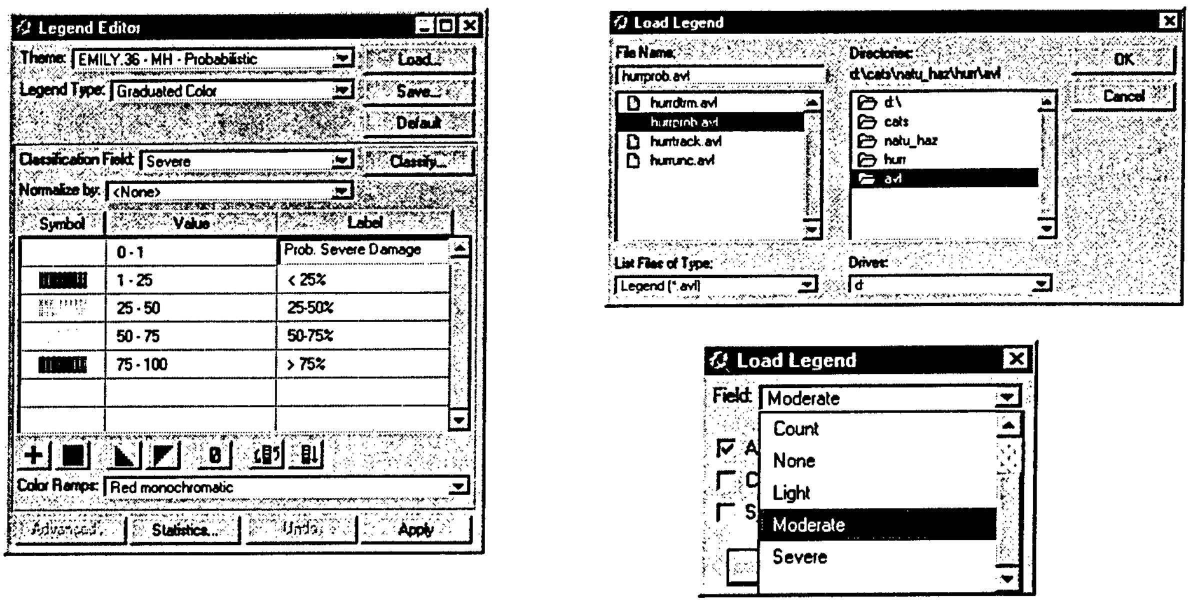


Figure 96. Legend Editor, File Service, Specify Field.

- Click ***Apply*** in the Legend Editor window (Figure 96). The view redraws to display the damage bands, illustrating probabilistic moderate damage to mobile homes. Finally, close the "Legend Editor" window by clicking on the box containing the "X" in its upper right-hand corner.

These actions have caused the Mobile Home damage theme, which had been displaying probabilities of *severe* damage to mobile homes, to display probabilities of *moderate* damage to mobile homes. (Similarly, probabilities of *light* damage can be displayed. Follow steps (1)-(4) as previously outlined in Section 6.1.3.3, except select *Light* in Figure 96.) *Be sure not to change the name of the theme, however, otherwise Consequence (population roll-ups) will not execute properly.* Figure 97 shows probabilistic moderate-damage bands from Hurricane Emily (with the CONUS relief map theme turned off).

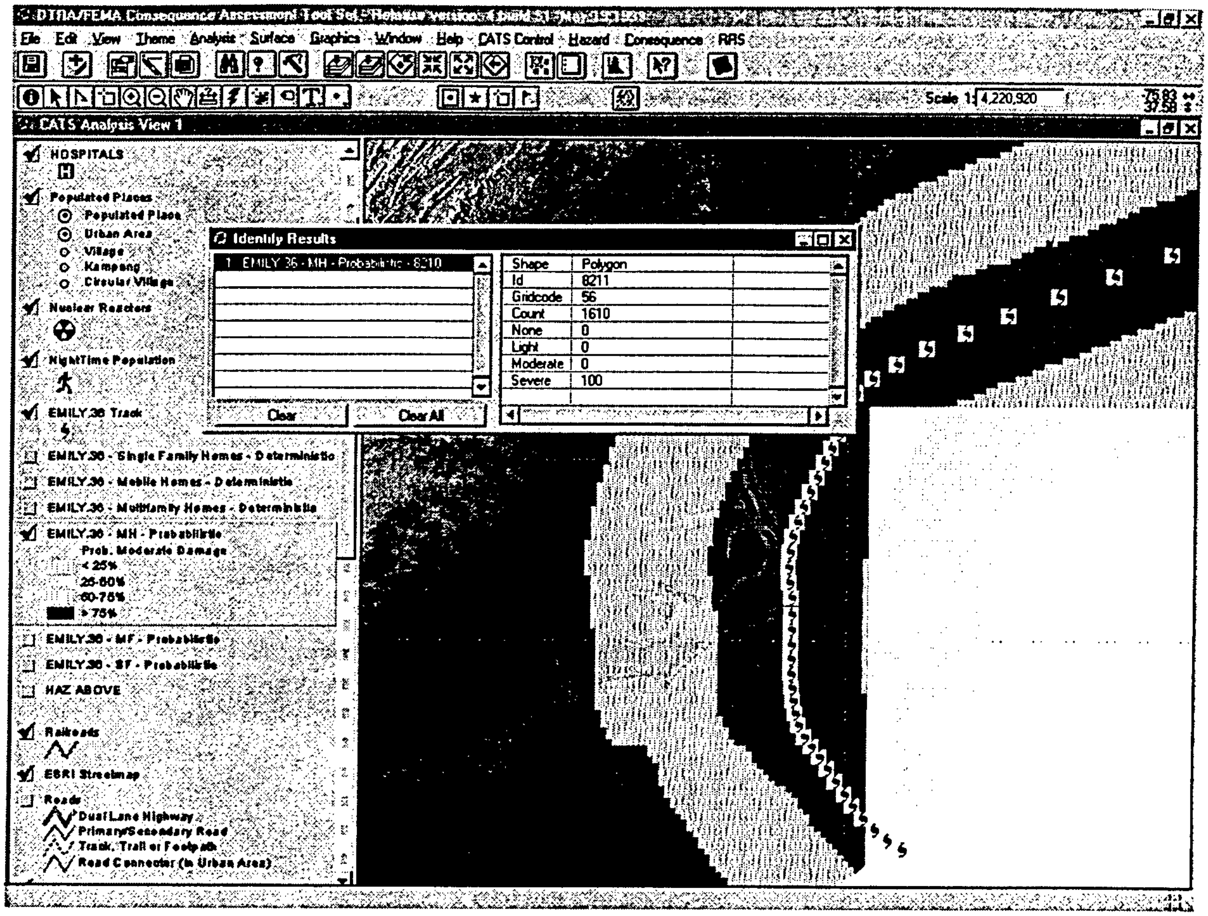


Figure 97. Probability of Moderate Damage to Mobile Homes.

Note the apparent "hole" in the inner portion of the damage bands, where it seems no damage has been calculated to occur. This indicates that the probability of moderate damage to mobile homes is indeed expected to be zero in this area. The damage here is entirely severe, with zero percentage moderate, as the "Identify Results" box indicates.

6.1.3.4 Viewing Deterministic Damage Bands.

Deterministic rather than probabilistic damage may be displayed by checking the probabilistic theme off, and checking on the deterministic theme. Deterministic damage bands become visible. A contrast to the probabilistic damage bands is provided in Figure 98, which displays the probability of severe damage to mobile homes. The innermost contour in Figure 98 (lower) represents a greater than 75% chance that severe damage to mobile homes will occur, whereas the innermost contour in Figure 98 (upper) indicates that all mobile homes in this area are expected to be subject to severe damage.

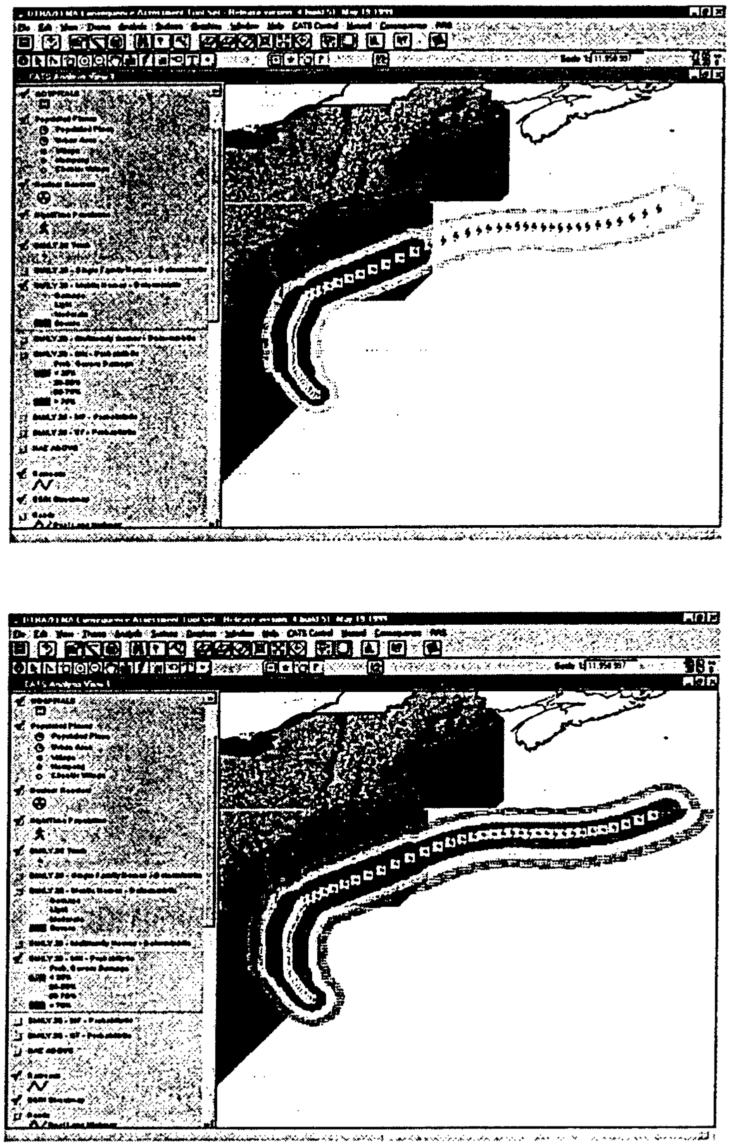


Figure 98. Deterministic (above) Probabilistic Severe Damage (below).

From the view shown in Figure 98, zoom in to the coast of North Carolina to produce a similar display to that shown in Figure 99. With the Identify tool, click in one of the shaded areas to illustrate the damage at that particular point. The damage level listed in the Identify Results box is *light, moderate,* or *severe,* depending on the location chosen.

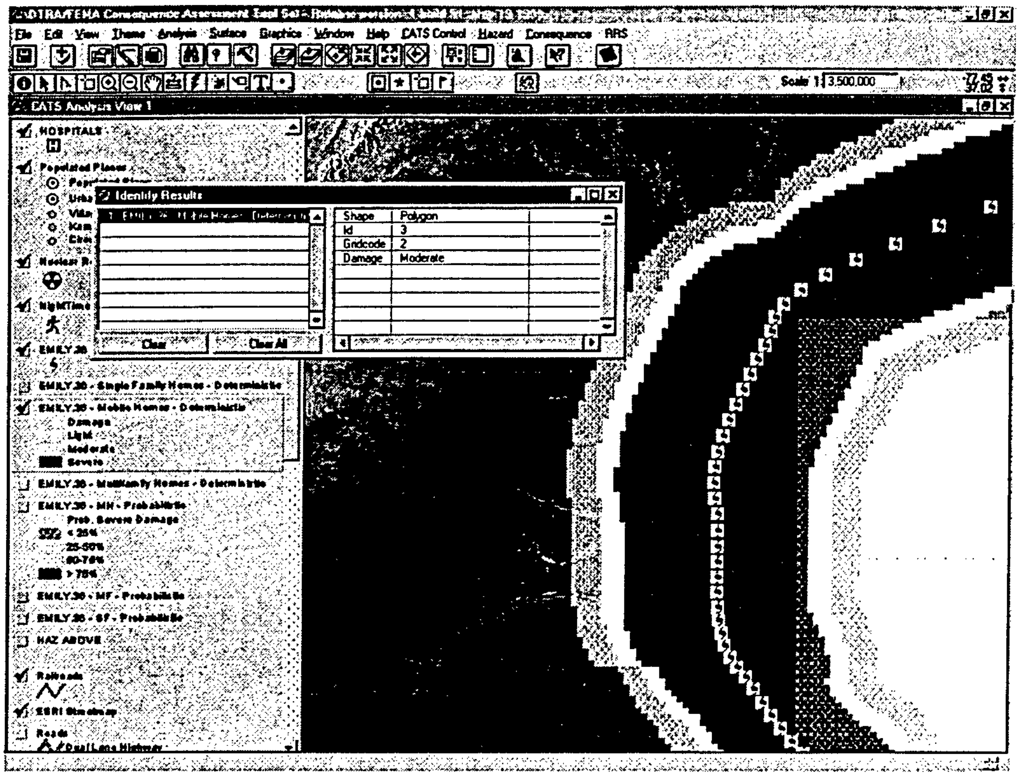


Figure 99. "Identify Results" for Deterministic Damage.

An important aspect of hurricane damage is the flooding caused by the abnormal rise of water generated by the storm. This phenomenon, referred to as "Storm Surge", is most responsible for the loss of life in a hurricane. Ninety percent of lives lost are to due rising waters and pounding waves. The next section addresses the CATS utility that models Storm Surge.

6.2 HURRICANE UNCERTAINTY.

6.2.1 Introduction.

The Hurricane Uncertainty model calculates product of probability distribution from a probabilistic damage calculation and the hurricane track probability. For example, if a hurricane track were assumed to hit Hilton Head, South Carolina, there might be a 70% chance of severe damage to mobile homes at that location. However, the uncertainty (or error) in the hurricane track forecast might stipulate only a 10% chance that the required wind speed would be present which would cause this severe damage. Therefore, there would exist only a 7% chance of mobile home severe damage in Hilton Head.

The damage bands associated with the hurricane uncertainty model output appear as color-coded contours showing probabilities of damage to structure types, as with the Hurricane model. However, the CATS Hurricane Model, discussed in Section 6.1, calculates projected damage and consequence assessment based on a hurricane track expected not to deviate from its forecast path. The CATS Hurricane Uncertainty Model also calculates projected damage, but takes into account the error associated with the forecast hurricane track by determining the probabilities of wind speeds at points within the *possible* path of the hurricane. Due to the nature of the probabilistic wind speed calculations, the Hurricane Uncertainty model damage bands appear as ellipses.

The forecast track of a hurricane contains a degree of uncertainty, so that there is a range of coastline where the storm might make landfall. The track error assigned in the forecast is based on historical data pertaining to how past hurricanes have deviated from their projected paths, and is region specific. For example, there is a greater

degree in projected track uncertainty at higher latitudes, because hurricanes undergo "re-curvature" there (curve away from the coast and head back out to sea) more often than at lower latitudes. Also, the farther the hurricane is from landfall, the greater the effect of the error in the projected track.

The algorithm for computing the probabilities of hurricane wind speeds is based on "Strike Probability" codes developed by the United States Navy. These codes would assume a specified hurricane track vector, and calculate the "strike" probability that the hurricane would pass within 65 nautical miles of a given location. This algorithm has been extended to calculate the probability that a given wind velocity will be present at a given location. As in the CATS Hurricane Model, a wind speed is calculated for a given location, and a breakdown of probabilistic damage is determined for that cell. However, the error in the track forecast is then used to calculate the "wind speed" probability for the particular location. This wind speed probability is then multiplied by the probabilistic damage breakdown for the particular cell. For more information on the details of the Hurricane Uncertainty model, see Appendix A, Section 4..

6.2.2 Hurricane Uncertainty Model Execution.

The Hurricane Uncertainty model is run in almost exactly the same way as the Hurricane Module (discussed in Section 6.1). Select ***Run Hurricane Uncertainty*** from the Hazards pull-down menu to open the window like that shown previously in Figure 90. This window lists the Advisory messages available from the various hurricane forecasts. Select the desired advisory message (such as Emily 36, for example) and click on ***OK***. The system will take a few seconds to parse the message and retrieve the necessary data and input this data into the model.

The final input process for running the module is selection of the structure types for which damage will be predicted, and is identical to that illustrated in Figure 91. The user may select one or multiple structure types. Click on a structure type to highlight that selection, for example, Mobile Homes. Click on other structure types to highlight them as well, such as Single Family Homes. Click on a highlighted structure type to deselect that item, if desired.

After all structure types have been selected press *OK* and the model will perform its calculations. **Note that The simulation takes more time than the Hurricane Model described in Section 6.1.** After the model run is finished, a window will open informing the user.

6.2.3 Hurricane Uncertainty Situation Display.

6.2.3.1 <u>Viewing the Damage Footprint.</u>

Figure 100 displays the results of a hurricane uncertainty simulation run for Hurricane Emily, using advisory message Emily 36. Turn on the desired damage theme, such as "Mobile Homes Moderate" to display the spatial distribution of the probability of achieving the expected moderate damage to mobile homes that might occur, taking into account the uncertainty in the hurricane track forecast, as well as the damage probability associated with wind strength. Separate damage themes showing probabilities of light, moderate and severe damage are created and loaded for each structure type that was input to the module. The probability distribution shown in Figure 100 can be compared with those from the Hurricane model, shown in Figure. The distinctive elliptical bands resulting from the Hurricane Uncertainty calculation are caused by the Probability of the Wind Speed at the particular location, which is multiplied by the Probability of Wind Damage to the given structure type to obtain the final value.

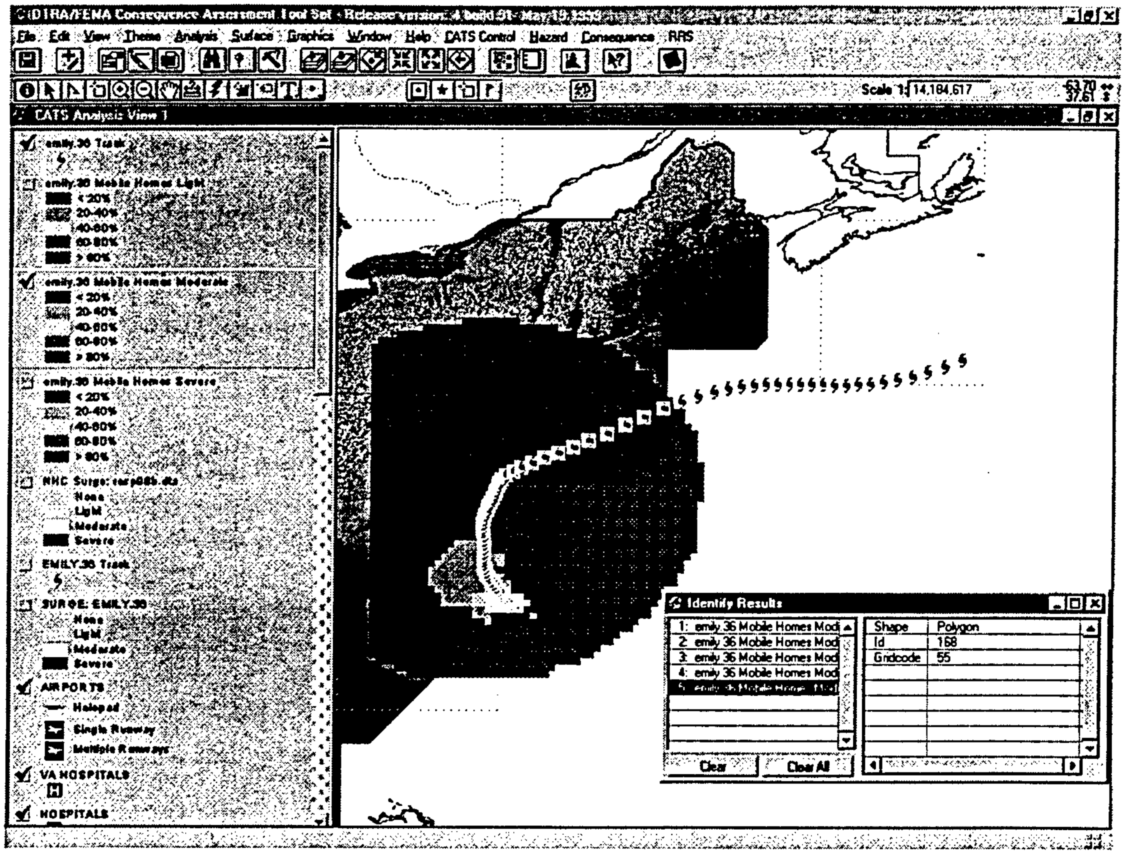


Figure 100. Display of "Hurricane Uncertainty" moderate damage to mobile homes.

Click in any desired cell in a certain shaded area with the Identify tool to examine the specific value of the probability of moderate damage to mobile homes, including hurricane track uncertainty. For advisory message Emily 36, and at the point selected in Figure 100, this damage probability is 55%.

6.2.3.2 Hurricane Uncertainty Population "Roll-Up".

Population roll-ups for Hurricane Uncertainty have not been implemented into CATS.

6.3 STORM SURGE.

6.3.1 Introduction.

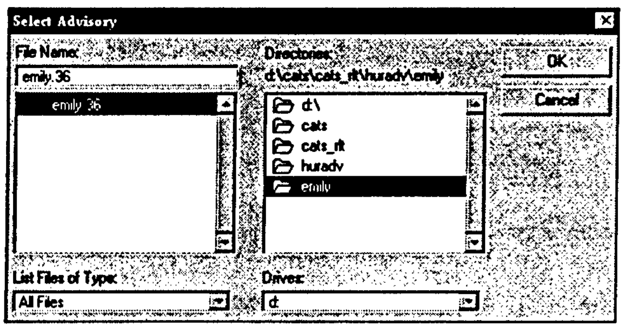
"Storm Surge", commonly referred to as "Surge", pertains to the abnormal rise of water generated by hurricanes and other large storms. The associated flooding presents a hazard to homes and buildings, and CATS contains a utility to simulate the flood depth and damage extent resulting from hurricane surge. Input parameters such as hurricane location, forecast track, and wind speeds within the storm, are needed to execute the model. These data are provided in the Marine Forecast/Advisory Messages issued by the National Hurricane Center in Miami, Florida, and are obtained as discussed in Section 6.1.

Using these data, CATS determines if and where hurricane landfall is expected to occur, and computes the radial wind profiles that describe the two-dimensional wind flow within the storm circulation. From these determinations, CATS identifies Maximum Envelope of Water (MEOW) data (or maximum surge height) appropriate for the threatening storm and the affected geographical areas. The MEOW data has been pre-calculated by the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) model. This extensive data set is a result of myriad simulated hurricane scenarios executed by various hurricane modeling agencies (with varying

hurricane locations, track headings, velocities, intensities, etc.), performed over a collection of vulnerable geographical areas. CATS selects the MEOWs that are relevant to the particular storm being examined, based on attributes such as the storm location, track heading, and storm velocity. Terrain elevation data is then combined with the selected MEOWs to form an estimate of surge magnitude, geographical extent, tide height, and flooded coastal areas. These estimates are useful to emergency managers, for they assist in assessing damage and consequences before the storm makes landfall. The model and its bases (such as the SLOSH model and the MEOW data sets) are described in detail in Appendix A, Section 3.

6.3.2 Storm Surge Model Execution.

Selecting ***Run Surge*** from the Hazards pull-down menu will open the window shown in Figure 101. This window will list the Advisory messages available from the various hurricane forecasts, from which the data described above are extracted in order to run the model. Select the desired advisory message (Emily 36, for example) and click on ***OK***. The system will take a few seconds to parse the message, retrieve the necessary forecast data, and input this data into the model. The user will be informed of the tide height in feet (Figure 101), and the completion of the run.



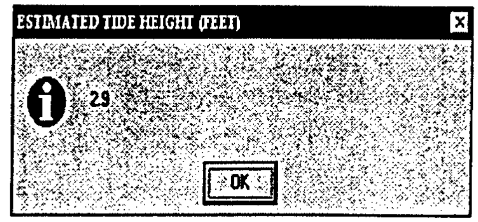


Figure 101. Select Advisory; estimated tide height (feet) report.

6.3.3 Storm Surge Situation Display.

6.3.3.1 Viewing the Damage Footprint.

When the run is finished, the window shown in Figure 102 appears, displaying the track of the storm responsible for the surge (Hurricane Emily, in this case), and the surge "footprint", seen here proximate to the coast of North Carolina (the surge footprint is very small in this view). Zoom in to the North Carolina coast and turn on any desired themes (Airports, Populated Places, Land Masses and Ocean, etc.) to create a display similar to the one shown in Figure 103, so that the surge area can be examined more closely. The various shades correspond to different degrees of damage. Damage is represented in terms of the depth of flooding (over and above whatever the terrain elevation is at the area in question); since this depth is independent of structure type, the damage displayed is to all types of structures. *Light* damage corresponds to flooding depths from one to two feet; *moderate* damage from two to ten feet, and *severe* damage above ten feet. Click on any cell in the surge footprint with the identify tool to display the depth of flooding and damage category at that particular point.

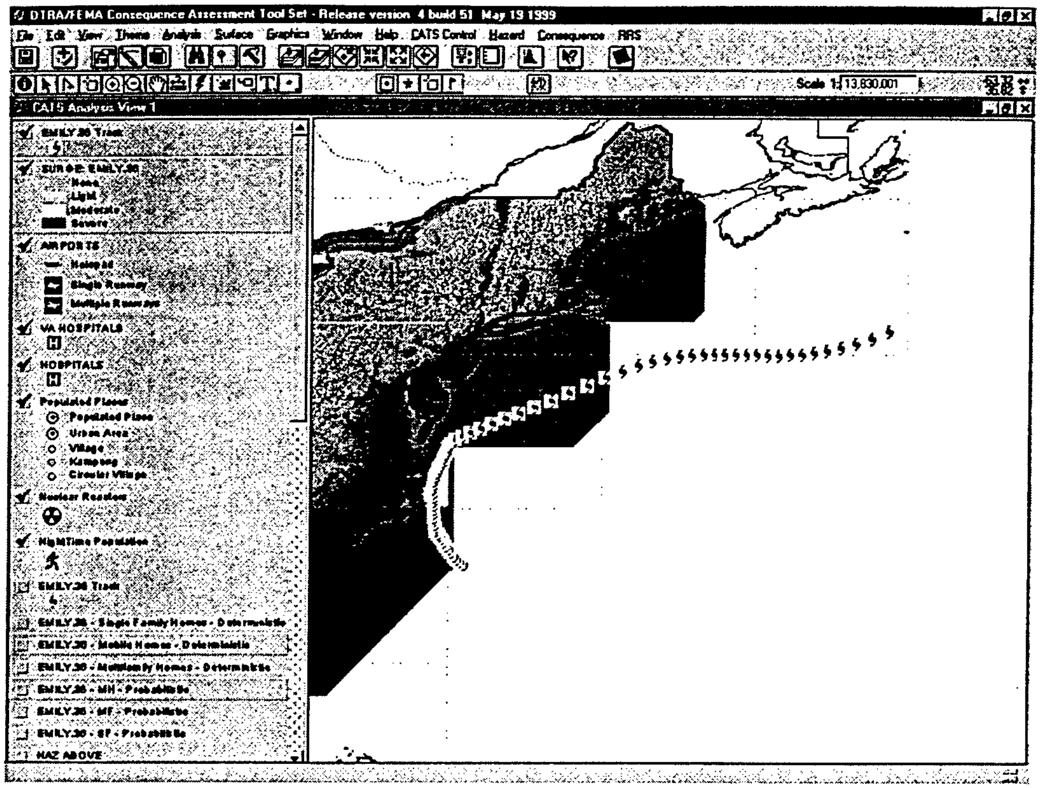


Figure 102. Storm surge footprint.

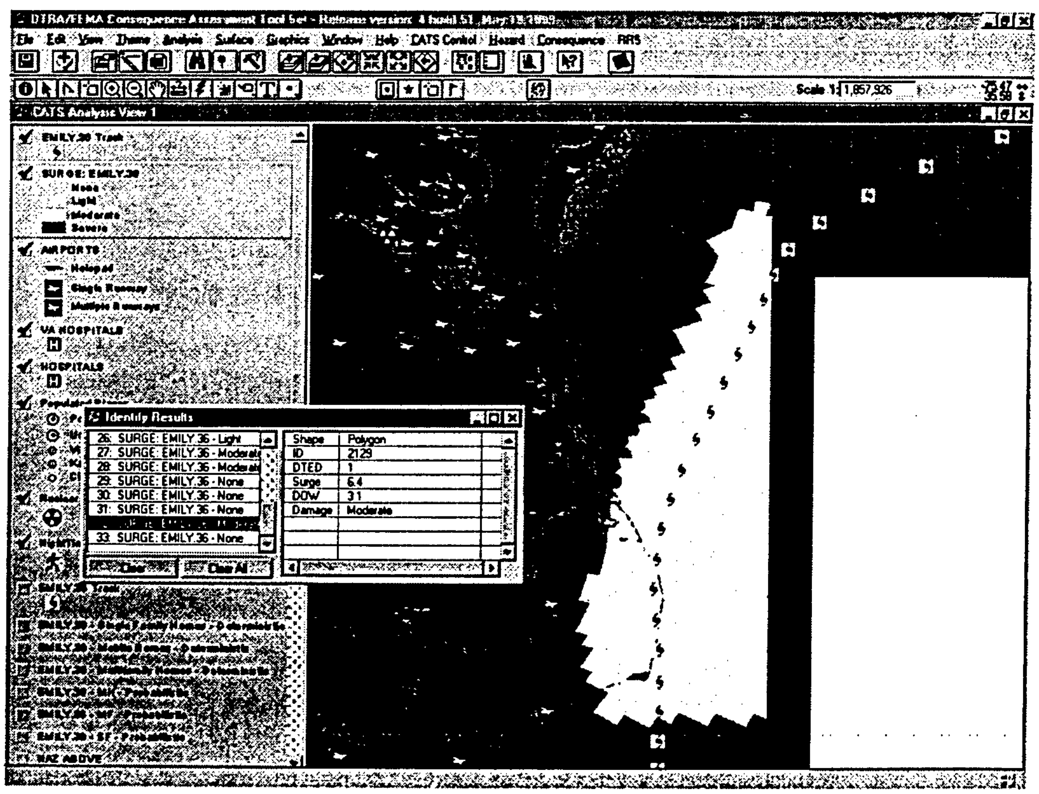
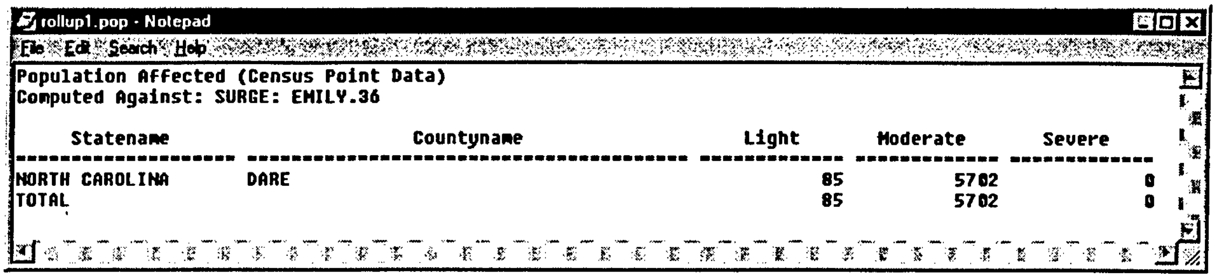


Figure 103. Storm Surge Damage and "Identify Results."

6.3.3.2 Storm Surge Population "Roll-Up".

Finally, selecting ***Pop Effects, SURGE: EMILY.36*** and ***1990 Census (State/County) Pt*** from the ***Consequence*** menu will calculate the expected numbers of persons at risk, resident in the specified structure type, as illustrated in Figure 104. Numbers of persons at risk are classified into three categories *(light, moderate, severe)* according to expected damage severity.


rollup1.pop - Notepad

File Edit Search Help

Population Affected (Census Point Data)
Computed Against: SURGE: EMILY.36

Statename	Countyname	Light	Moderate	Severe
NORTH CAROLINA	DARE	85	5702	0
TOTAL		85	5702	0

Figure 104. Storm Surge Population "Poll-Up."

CATS also displays results from an additional Surge model, developed by the National Hurricane Center. This is discussed next.

6.4 NHC SURGE.

6.4.1 Introduction.

"NHC Surge" refers to the Storm Surge model developed by the National Weather Service and the National Hurricane Center, and demonstrated at the Response 95 exercise. The model itself is not resident in CATS, but examples of its results are. It differs from the CATS Storm Surge model in that it does not rely on composite MEOW data to determine depth of flooding. That is, the CATS model uses pre-defined MEOW data based on many simulated SLOSH hurricane scenarios, matching the data to the characteristics of the storm in question. Suppose that the threatening storm is a category 3 storm 200 miles due east of Hilton Head, South Carolina, heading Northwest at 10 mph. CATS will select MEOW data that resulted from many simulated hurricane runs for category 3 storms near this location, with similar headings and velocities. Remember, the flood depth selected by CATS is the maximum calculated from the many simulation runs. As such, this model actually overestimates the extent of the damage. It is therefore commonly used as a planning tool to determine the geographic areas that might be prone to flooding, so that precautionary measures can be taken.

The National Hurricane Center usually runs the NHC Surge Model for a storm within 6-12 hours of making landfall. This is because at this point in time, there is a relatively high degree of confidence as to the location of the projected landfall. Executing the model while the storm is further away from the coast is precluded due to the large degree of uncertainty in the storm track forecasts. A SLOSH simulation *run for this specific event* is made, using data from "short lead-time" (6-12 hours before landfall) advisory messages. The depth of the surge flooding is actually calculated by the SLOSH model for this specific event, rather than being estimated by selecting the maximum flood-depth from an ensemble of simulation runs for a storm of similar location, heading, and velocity.

At this time, NHC Surge is included in CATS as a demonstration utility to illustrate its existence and examples of its results. It is not intended to provide the user with a useful tool for routinely estimating surge extents. The code and functionality that the model uses cannot be provided in CATS; rather, two model outputs are provided with the software, both for storm surge near the Northeastern coastline of the United States. The steps involved in viewing these outputs are discussed next.

6.4.2 NHC Surge Model Execution.

Selecting ***Run NHC Surge*** from the ***Hazards*** pull-down menu will open the window shown in Figure 105. This window will list the two NHC Surge coverages available in CATS that the NHC has provided. Select the desired surge file and click on ***OK***. The system will take a few seconds to retrieve the necessary data, and convert it to the proper GIS format. The user will be informed when this is completed.

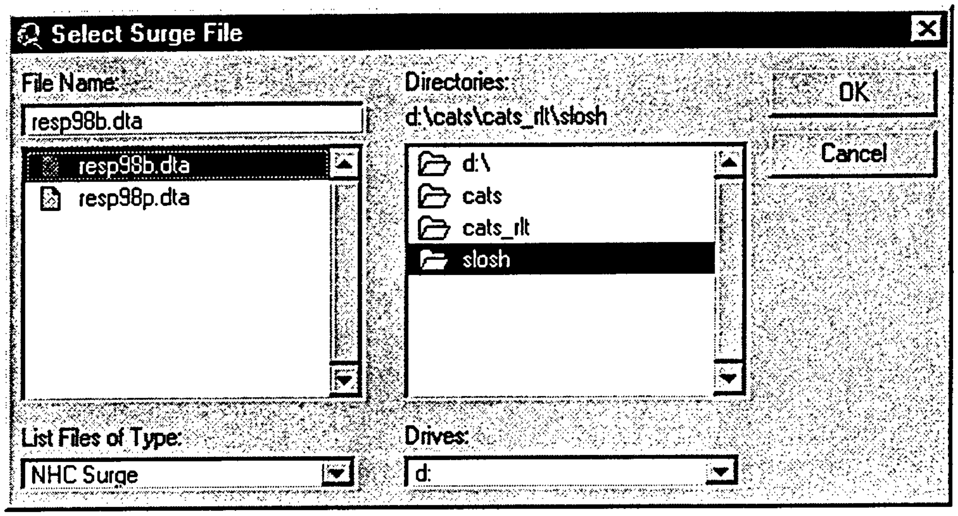


Figure 105. Selection of NHC Surge Coverage.

6.4.3 NHC Surge Situation Display.

6.4.3.1 Viewing the Damage Footprint.

Results of an *NHC Surge* display are shown in Figure 106. Damage criteria (flooding depths) are categorized as are those in the Storm Surge module (see Section 6.2). The "identify Results" box displays both the damage level *(moderate,* in the figure) and the flood depth in feet at the point selected; terrain elevation is not taken into account. Population roll-ups with NHC Surge are not functional.

6.4.3.2 NHC Surge Population "Roll-Up".

Population, infrastructure and housing at risk roll-ups for NHC Surge may be calculated in CATS.

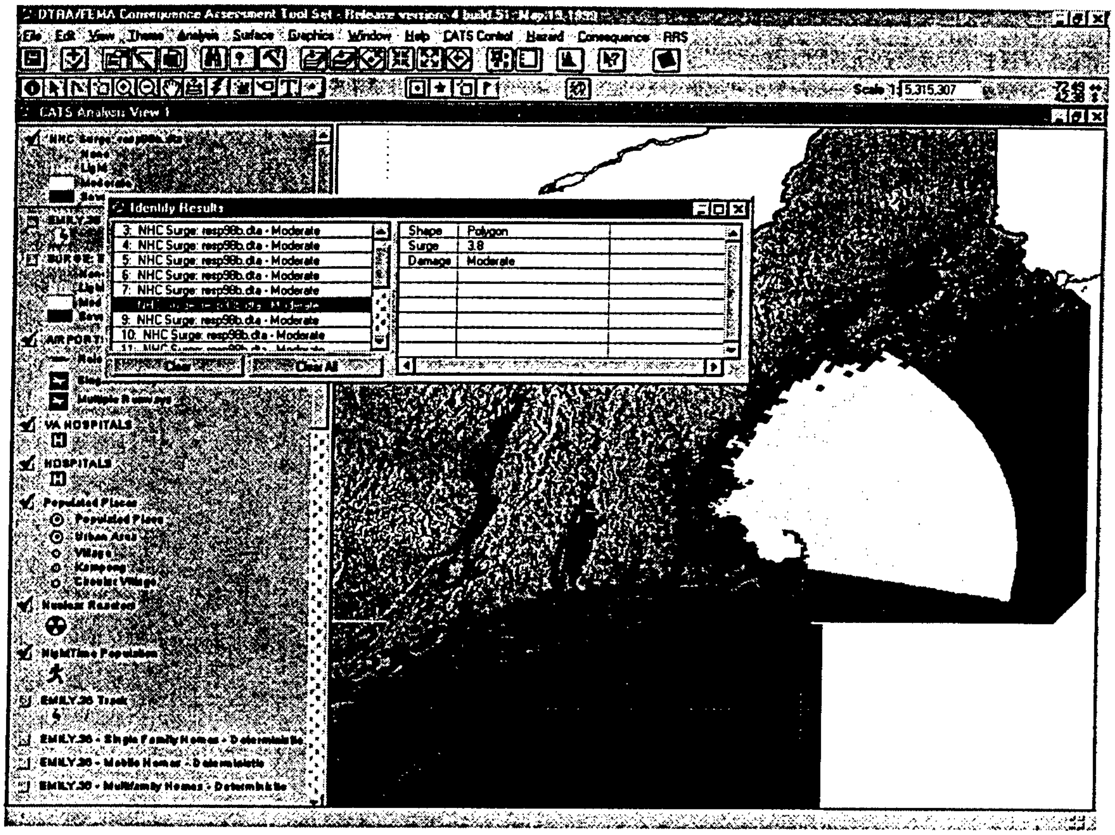


Figure 106. NHC Surge Output Display.

6.5 EARTHQUAKE

6.5.1 Introduction

The CATS Earthquake Model is a collection of programs that compute the predicted extent and degree of impact of an earthquake. Computer models and digital databases are utilized to calculate the impact of a damaging earthquake in terms of the facilities, infrastructure, and population at risk. The Earthquake Model simulates the severity and the geographical extent of the damage due to the primary earthquake hazard of ground shaking. The model calculates the physical effects of the earthquake hazard being simulated. The output will consist of raster images (a type of ArcView shape file) containing, for the types of facilities selected, the spatial distributions of expected damage levels and of damage probabilities. Damage levels are determined in terms of the ratio of structure repair costs to structure replacement costs. They are classified into three levels, *light, moderate,* and *severe.*

6.5.2 Earthquake Model Execution.

Before executing the CATS Earthquake Model, two tasks need to be performed:

A geographical area must be selected to define the spatial domain of the simulation by selecting the ***Earthquake Damage Area*** tool from the lower ArcView toolbar. Use this tool to define a "box" by clicking and dragging the pointer as shown in Figure 107 (around the San Francisco bay area, for example). The window displayed in Figure 108 will appear, prompting the user to select the region of the world from which geology data is to be loaded and utilized by the model. Data is available for Alaska, California, the Continental United States (CONUS), Japan, and the rest of the world. The state data is the most highly resolved; next is CONUS, and then Japan. World data is the coarsest and should only be used when no other data is available. Select ***California*** for this hypothetical example, set in San Francisco.

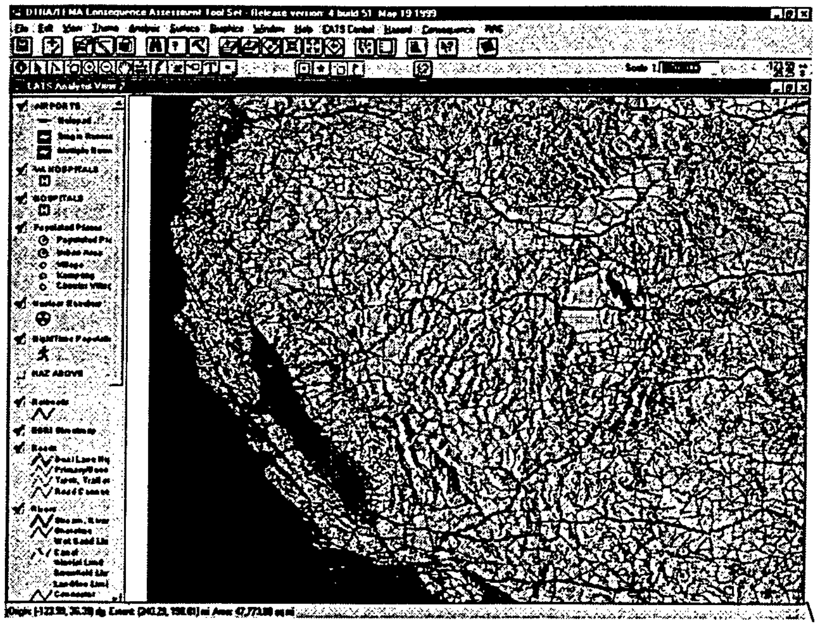


Figure 107. Selection of Earthquake Hazard Area.

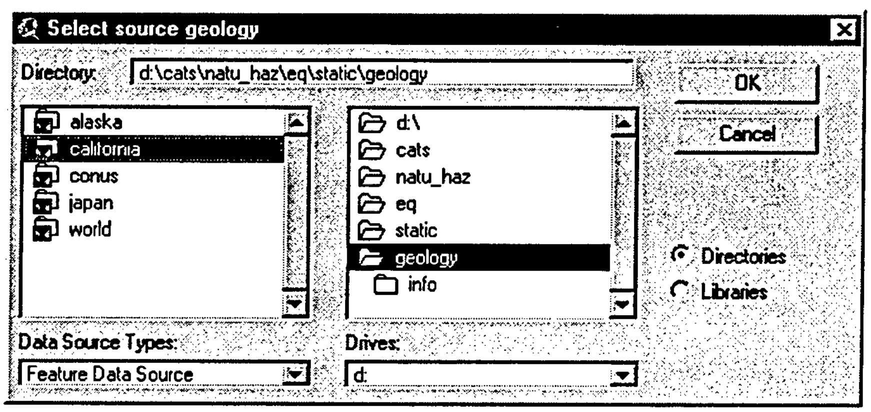


Figure 108. Selection of Source Geology Data.

Next, select the geological grid resolution, which is required for the model calculation and the output display, as shown in Figure 109. Finer resolutions produce more detailed outputs, but require more computing time. Select the desired resolution, choose *OK* and wait for the Geology Data Base "Clipper" to be *DONE*.

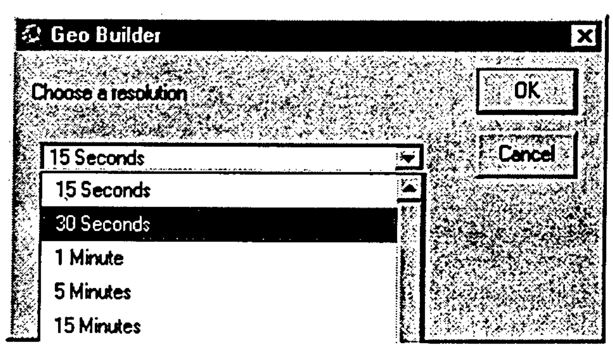


Figure 109. Selection of Geological Data Resolution.

After preparation of the geological data has been completed, the user:

- **MAY** set the fault segment in which the quake occurs. Click on the ***Fault Selection Tool*** to display the locations of known faults in the active View. Place the cursor successively on each end of the fault segment from which the quake originates. This sets the Fault Angle.

- **MUST** define earthquake epicenter. Click on the ***Hazard Origin tool*** (right next to the Earthquake Damage Area tool) and then click within the area previously defined by the damage area box. It is customary to place the epicenter near the center of the boxed damage area, and mandatory to place it somewhere *within* this area. If you have a message containing the exact location of the epicenter, such as those posted on the internet by the USGS (http://quake.wr.usns.gov/cgi-bin/quake/gldfs.cr.usgs.gov), then you may simply type the coordinates into the GUI in Figure 110.

After selecting the ***Run Earthquake*** menu item from the Hazard pull-down menu, the window shown in Figure 110 will open. Enter the parameters of the earthquake to be modeled (for example, those shown in the figure) and select ***OK*** to continue. Following is an explanation of each of the parameters input through this window to predict the damage of an earthquake. Input of the numerical parameters are to be performed using numbers between the given ranges. No units are to be entered into the parameter input fields.

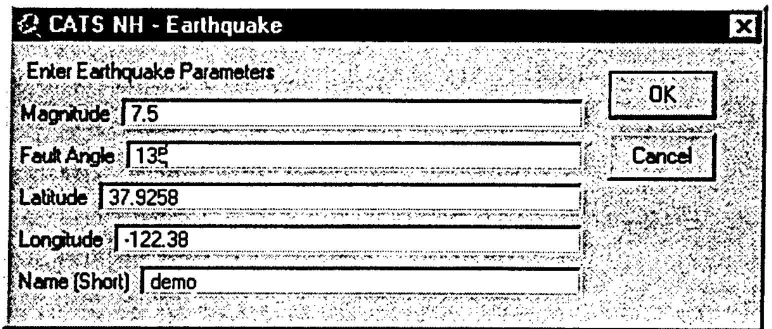


Figure 110. Earthquake Model Input Parameters.

Magnitude: The appropriate magnitude, as an indication of the size of the earthquake (i.e., the total energy release) for input to the earthquake model is based on the seismic energy carried by the damage-relevant seismic phases. Therefore, the earthquake magnitude for input to the model is either the local magnitude (M_l) or the surface wave magnitude (M_s). M_l determinations use the largest recorded amplitude, typically with a period near one second (i.e., near the resonant frequency of the instrument). The M_s scale is particularly useful for shallow focus earthquakes (less than 70 km). The scale is completely general, not being tied to any particular seismograph or to any particular epicentral distance. M_s is usually reported by national networks for moderate and large earthquakes occurring at tele-seismic distances. The magnitude scale cannot be used to characterize deep, or relatively small, regional and local earthquakes.

Earthquake reports issued promptly by government and academic seismological observatories after an earthquake routinely contain the M_s magnitude for shallow earthquakes of moderate magnitude and larger. Regional seismograph networks, focusing on small, local earthquake activity, usually report M_l. M_l is reported generally for small, shallow earthquakes by national networks. M_l is consistently a few tenths of a magnitude scale unit less than M_s, up to saturation.

The chief significance of the magnitude lies in its direct relationship to the total elastic wave energy released by the earthquake. (Wave amplitude, used in the magnitude calculation, is a measure of the elastic work done in straining the ground.) The earthquake model uses the familiar Gutenberg-Richter empirical law (Richter, 1958) to relate total seismic wave energy, E, to surface magnitude, M_s:

$$\mathrm{Log}_{10}E = 11.8 + 1.5\, M_s$$

The range of magnitude values acceptable for this model is from 3 to 10. The model will compute damage results when the magnitude falls within this range. Earthquakes with magnitudes below 3 are considered too small to produce significant damage or any damage at all.

Fault Angle (Strike of Rupture): The rupture is described fundamentally in terms of its strike and depth. (The description of the fault rupture is completed by the specification of the length of break, which is calculated by the model from the magnitude for the appropriate attenuation factor.) The strike is the azimuth (compass bearing) of the fault. It is entered in decimal degrees clockwise from north, and can be any angle from 0 to 360 degrees. (The fault angle of a fault with a northwest-southeast strike can be entered as either 135 or 315 degrees.) The angle is measured from the fault line along the earth's surface (horizontal plane).

The earthquakes fault angle should be arrived at by studying fault maps of the epicentral area. In the absence of these, a first guess should be that the major geophysical features of an area approximate the faults of an area. For example, the west coast mountain ranges in California and Oregon tend to have faults that follow them. Earthquakes along an island chain are likely to follow the chain, so that in Hawaii, the fault angle might be represented well by an angle of about 290/110 degrees.

Latitude and Longitude (Center of Rupture): The fault rupture, modeled as a linear break, centered on the epicenter, is defined as the point on the earth's surface vertically above the source. Conversely, the reported earthquake epicenter is taken as the center of the fault rupture. (Epicenter and magnitude reports are normally issued promptly by government and academic observatories.)

The geographic coordinates of the epicenter are entered in decimal degrees. North latitudes and east longitudes have positive values, while south latitudes and west longitudes have negative values.

The values acceptable for input into the model for the latitude are from -90 to +90 degrees. The acceptable values for the longitude are from -180 to +180 degrees.

Name (Short): The name of the scenario is entered, and should be less than or equal to 8 characters. Scenarios are archived so they can be easily retrieved for future use.

The next window, shown in Figure 111, requires the Event Type to be entered. The default Event or Fault Type for the earthquake model is strike-slip. Transform-faulting, exhibiting strike-slip fault motion, is the most prevalent type of faulting. The buff on for strike-slip faulting is automatically depressed on both blank Input Parameter Screens called by the User-Defined Option, and Input Parameter Screens partially filled in with the USGS bulletin. By default, the depth of fault rupture is set automatically to 25 km.

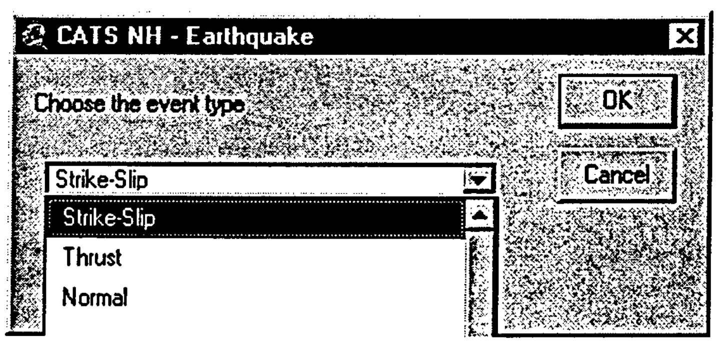


Figure 111. Event Type Input Window.

The earthquake ground motion model only allows for thrust, strike-slip, and normal types of faults. A strike-slip fault is a vertical or high-angle fault where the direction of slip (i.e., the direction of movement along the fault) is purely horizontal. A thrust or reverse fault is a low-angle fault where the direction of slip is parallel to the dip

direction, and the hanging wall (the crustal block overhanging the fault plane) moves up and over the foot wall (the crustal block underlying the fault plane). A normal fault is an intermediate angle fault in which the slip is in the dip direction, and the foot wall moves under the hanging wall. Generally, fault type is determined in conjunction with fault strike. Guidance is provided by one or more of the following: nearby mapped faults, nearby major tectonic features, the fault planes of previous nearby earthquakes. As with fault azimuth, guidance for inferring the fault type is provided by the type and location of the known faults and other tectonic features close to the epicenter. An earthquake that occurs near a known thrust fault, is located in a belt of thrust activity, or is located near a tectonic feature produced by thrusting, may itself be attributed to a thrust fault. Be aware, however, that a strike-slip fault may have ruptured to accommodate offset.

If the earthquake epicenter is located offshore and in or near an ocean trench, the causative rupture most likely occurred on a thrust fault. Therefore, the mouse should be manually clicked on the button 'Thrust' for a thrust fault. The rupture depth is then set automatically to 20 km. If the earthquake epicenter is located on or near a mid-ocean ridge, it is most likely that the causative rupture occurred on a normal fault. Therefore, the mouse should be manually clicked on the button for 'Normal' for a normal fault. The rupture is then set automatically to 30 km.

After entering the Event Type, select *OK*. This will bring up a GUI (Figure 112) asking whether the user would like probabilistic damage or deterministic damage computed. These are defined as follows:

- ***Probabilistic:*** Computes the spatial distribution of the probability that a specific level of damage *(light, moderate, severe)* will occur for a specific structure type

- ***Deterministic:*** Determines the expected spatial distribution of the levels of damage *(light, moderate, severe)* for a specific structure type.

After entering the damage Calculation Type, select ***OK***.

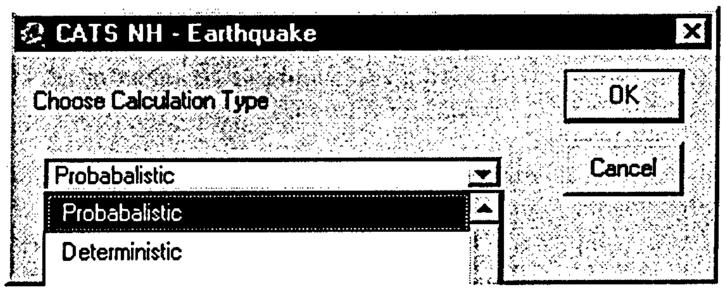


Figure 112. Choose Calculation Type.

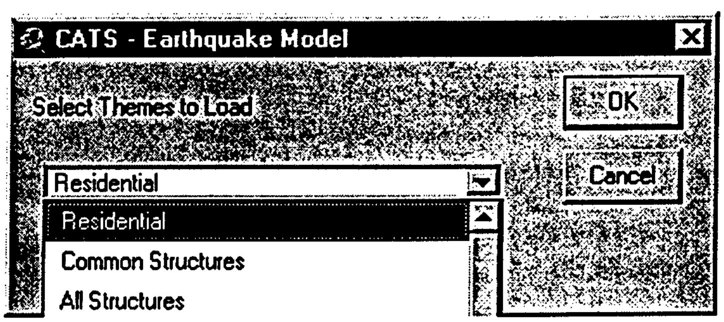


Figure 113. Select Structure Types.

Next, the user selects the types of structures to which damage is to be determined, and runs the damage model (see Figure 113). There are eighty-six structure types for which damage can be computed. For probabilistic damage, the user has the choice of selecting to compute damage to the following structure classes:

- Three residential structure types (single family homes, mobile homes, and multifamily homes [apartment buildings]),
- **Common structures** (a set of about 15 structure types including the residential structures and other common structures such as hospitals, office buildings, bridges, etc.), and
- **All eighty-six structure types**. The user is afforded this choice because the calculation of probabilistic damage can take up to 15 minutes for all 86 structure types.

Deterministic damage is calculated by default for all eighty-six structure types since the execution time is relatively quick. Once the user has made the selection and has clicked *OK*, the damage calculation model executes. When the calculations are complete, a window appears informing the user, and the themes appear in the view.

6.5.3 Earthquake Model Situation Display.

This section describes how to view the output from the CATS Earthquake Model simulation whose inputs were described in Section 6.5.2 (Probabilistic Earthquake Damage). By default, the model displays the spatial distribution of the probability of severe damage, but viewing probability distributions of other damage levels is possible and will be discussed subsequently.

6.5.3.1 Viewing Probabilistic Severe Damage Bands..

When the model is finished executing, zoom in around the bay area to produce a close-up view of the scenario. Turn on the earthquake damage theme, along with any other desired themes (Earthquake Epicenter, Land Masses and Ocean, Lakes, Roads, Airports, Populated Places, etc.) to produce a window similar to that illustrated in Figure 114.

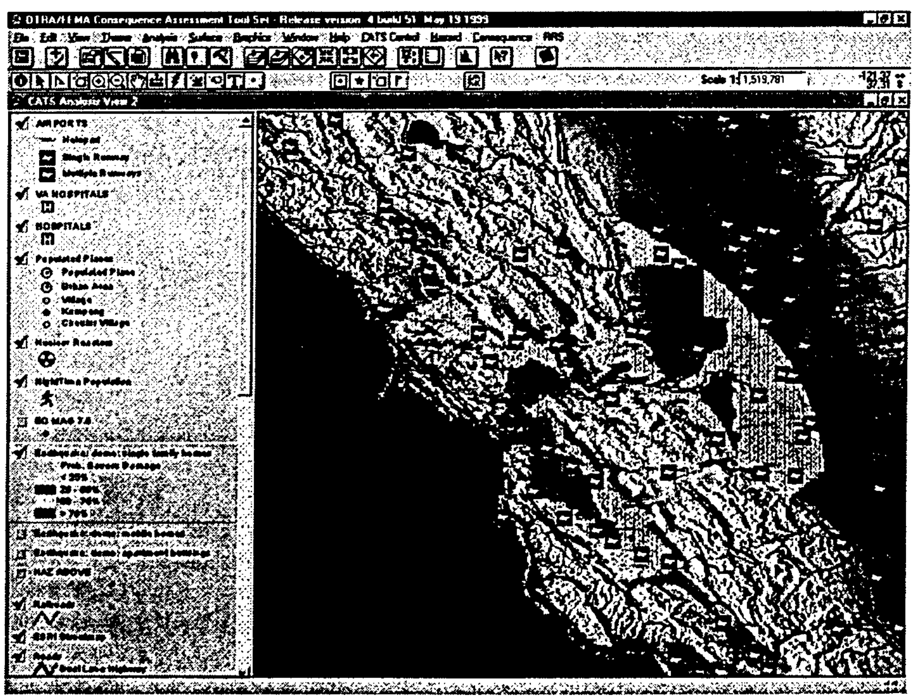


Figure 114. Earthquake Probabilistic Severe Damage to Single Family Homes.

Displayed by default is the spatial distribution of the probability of *severe* damage due to the earthquake. Since almost all of the predicted probability of severe damage is less than 25%, one can get a better idea of predicted damage by selecting a different damage level for viewing: *light* or *moderate*.

6.5.3.2 Viewing Probabilistic Light or Moderate Damage Bands.

To do this, double-click on the damage theme to open the Legend Editor window, shown in Figure 115, and then click ***Load***.

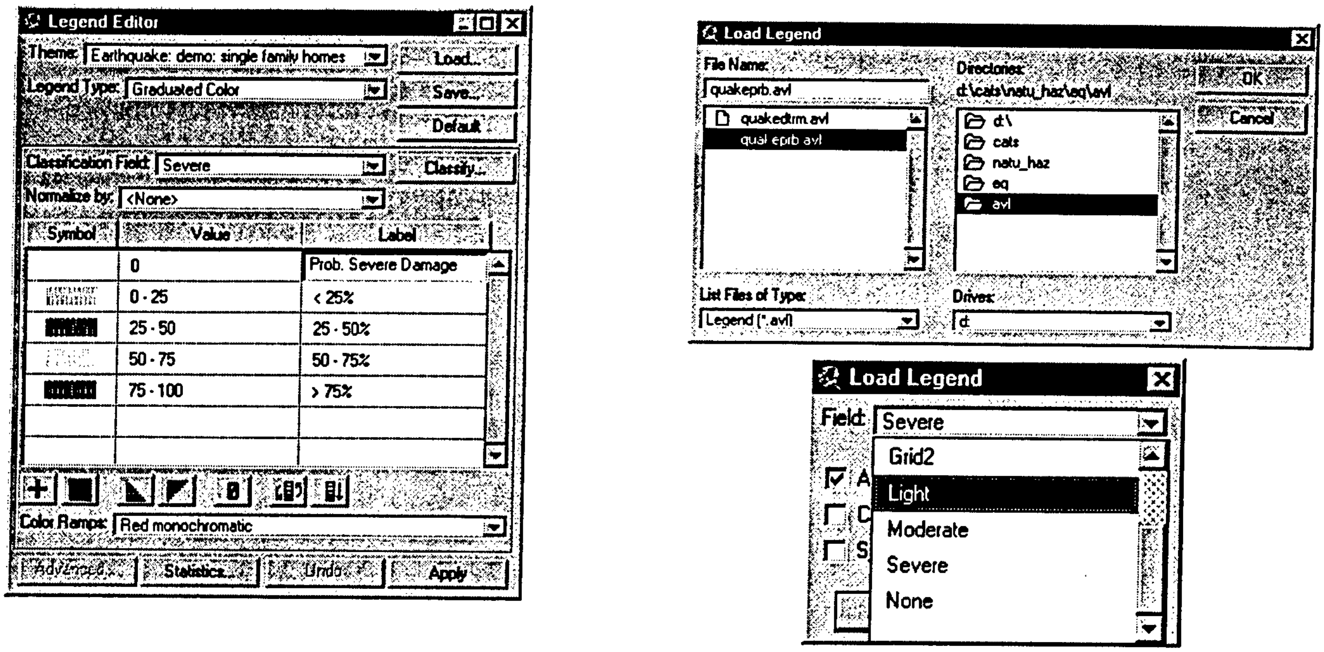


Figure 115. Legend Editor, Earthquake legend; File Service; Specify Field.

Navigate to *quakeprb.avl,* as shown in Figure 115, and click ***OK;*** next, e.g., select *Light* as shown in Figure 115. Make sure the *All* box is checked. Click on the *Apply* box in Figure 115 to apply the changes, and close the Legend Editor window to see the geospatial probability distribution of light damage to single family homes. A picture similar to that shown in Figure 116 will appear, displaying the different colors of light damage probability areas. To view the probability of moderate damage, simply select *Moderate* in Figure 115. The rest of the procedure is the same as for light damage.

Note: Do not change the theme name, however, in any of these cases, as Consequence (discussed later) will not work properly.

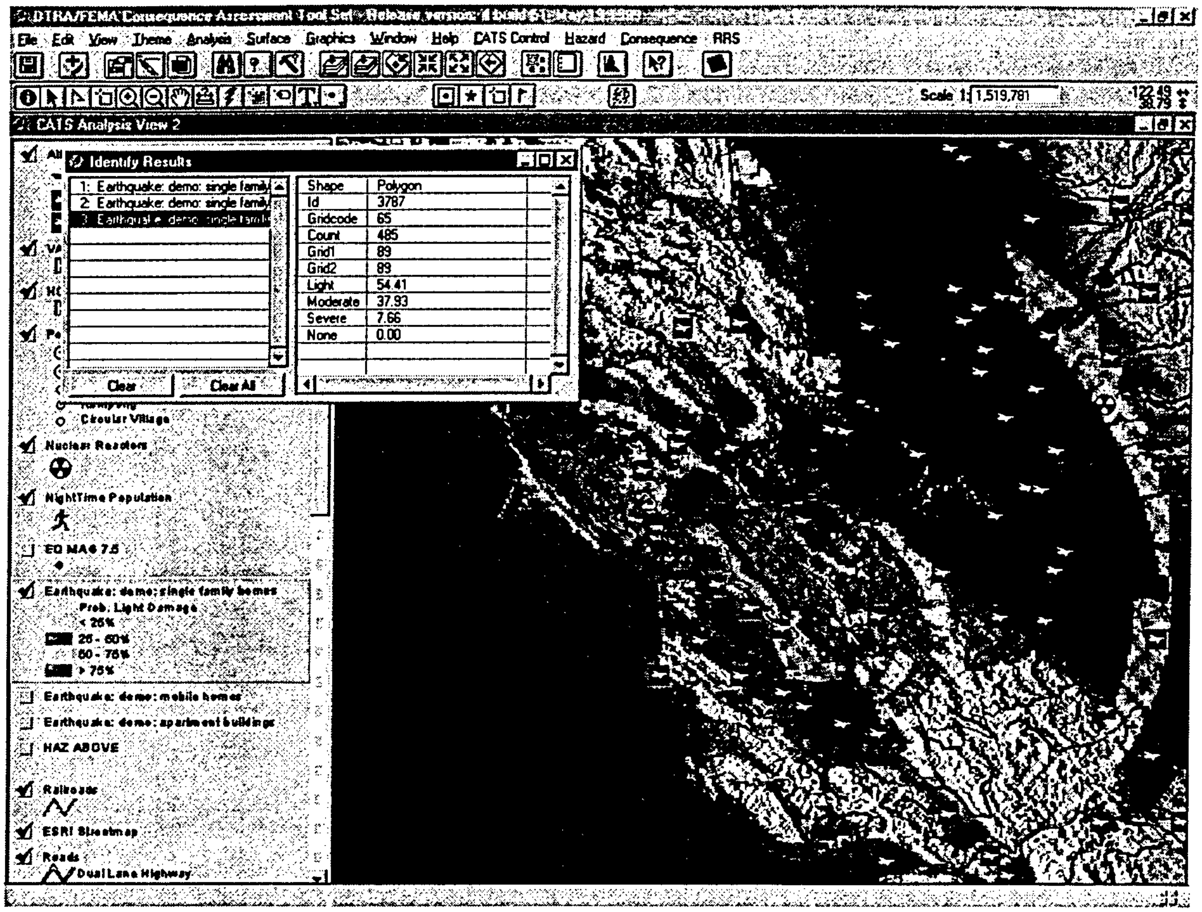


Figure 116. Earthquake Probabilistic Light Damage.

Select the ***Identify tool***, and click near the epicenter, in a yellow area where the probability of light damage should be in between 50% and 75%. An "Identify Results" box will appear with information of the damage breakdown at the particular location selected. For example, at the point selected in the figure, there is a 54.41% chance of light damage to single family homes. However, this is not the only probability of damage that is expected. There is also a 37.93% chance of moderate damage, a 7.66% chance of severe damage, and a 0% chance of no damage.

Light damage signifies damage of some building components not generally needing repair. Moderate damage refers to damage of many building components that need repair. Severe damage signifies extensive damage of all building components, so that the structure must be completely repaired or destroyed.

6.5.3.3 Earthquake Model Population "Roll-Up".

To determine the expected number of persons at risk residing in a given structure type (single family homes, in this case), make sure the damage theme, Earthquake: Single Family Homes, is active. That is, click on this theme in the left-hand column of the viewscreen so that a box becomes visible around it. Then select *Pop Effects and then 1990 Census (State/County) Pt* from the *Consequence* menu. The calculation will take a couple minutes, and the window shown in Figure 117 will appear. Displayed are the numbers of persons at risk (living in single family homes, for this example) whose homes are expected to experience light, moderate, and severe earthquake damage.

rollup2.pop - Notepad

File Edit Search Help

Population Affected (Census Point Data)
Computed Against: Earthquake: demo: single family homes

Statename	Countyname	Light	Moderate	Severe
CALIFORNIA	ALAMEDA	510999	191746	38224
CALIFORNIA	COLUSA	9519	79	0
CALIFORNIA	CONTRA COSTA	478524	62553	9172
CALIFORNIA	EL DORADO	81	0	0
CALIFORNIA	LAKE	10573	112	1
CALIFORNIA	MADERA	4776	0	0
CALIFORNIA	MARIN	117034	16873	3189
CALIFORNIA	MENDOCINO	3161	0	0
CALIFORNIA	MERCED	8989	0	0
CALIFORNIA	MONTEREY	47711	613	34
CALIFORNIA	NAPA	52345	3804	278
CALIFORNIA	PLACER	24168	4	0
CALIFORNIA	SACRAMENTO	576026	8845	40
CALIFORNIA	SAN BENITO	8187	0	0
CALIFORNIA	SAN FRANCISCO	118794	22200	4565
CALIFORNIA	SAN JOAQUIN	301033	13534	603
CALIFORNIA	SAN MATEO	329788	33795	3660
CALIFORNIA	SANTA CLARA	817684	49617	3072
CALIFORNIA	SANTA CRUZ	80816	191	13
CALIFORNIA	SOLANO	209155	8579	1093
CALIFORNIA	SONOMA	198793	25059	3460
CALIFORNIA	STANISLAUS	161187	21	0
CALIFORNIA	SUTTER	39851	193	0
CALIFORNIA	YOLO	77159	2155	35
CALIFORNIA	YUBA	26690	94	0
TOTAL		4213043	440067	67439

Figure 117. Expected Numbers of Persons at Risk in Single Family Homes.

6.5.3.4 Deterministic Damage Calculation and Situation Display.

Previously, the user has been guided through executing the Earthquake Model in probabilistic damage mode. The model can also predict deterministic damage; an explanation of deterministic damage vs. probabilistic damage was provided earlier. The same steps are taken to calculate deterministic damage as were taken for calculating probabilistic damage, as outlined in Section 6.5.2. The output footprint looks slightly different, however, and it is instructive to compare the two and explain the differences. Figure 118 displays examples of probabilistic light damage and deterministic damage, respectively, for the San Francisco Bay Area earthquake scenario illustrated earlier. The same inputs as shown in Figures 110 (earthquake magnitude, epicenter location, etc.) and 111 (Strike-Slip earthquake type) were used for each of these cases, and damage was calculated to Single Family Homes for each case.

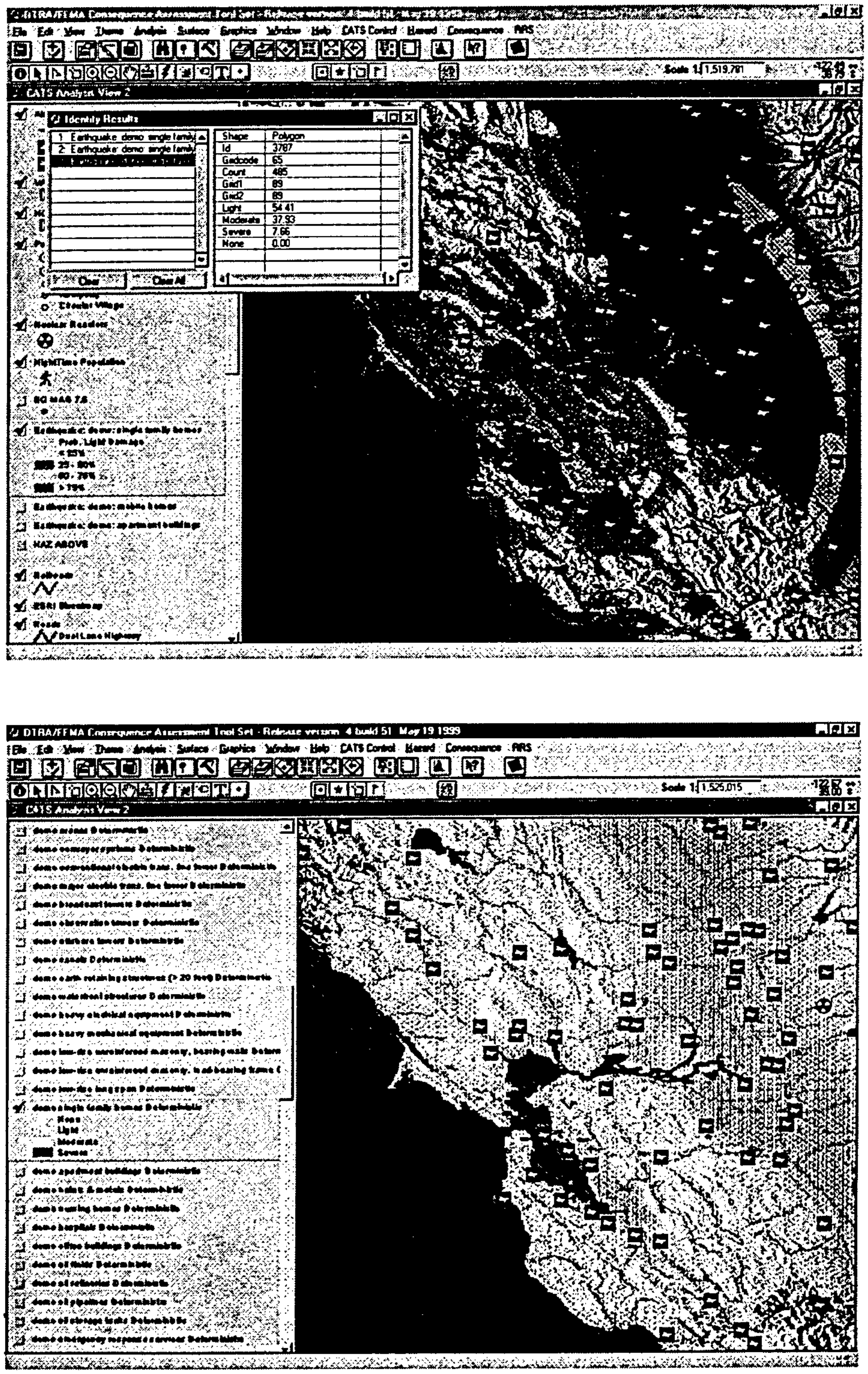


Figure 118. Earthquake hazards: Probabilistic Light Damage (above); Deterministic Damage (below).

Figure 118 (upper) illustrates the spatial distribution of the probability of *light* damage for the specified earthquake scenario. The different colors correspond to different light damage probability ranges. Figure 118 (lower) is different, for it displays the spatial range of deterministic damage. The three different colors shown in figure 6-30b do not denote probability ranges; rather, they correspond to three different discrete damage levels: light, moderate, and severe. That is, the severity of the earthquake at a certain location produces one of these three damage types, to a specific type of structure, at that location. The entire spectrum of deterministic damage to that structure type is visible on one screen. This differs from probabilistic damage, where, for a certain shaking intensity, the color-coded "footprint" only displays the spatial distribution of *one* level of probabilistic damage. However, the damage probability breakdown is shown in the "Identify Results" table for light, moderate, and severe damage.

The "Identify Results" box in Figure 118 (deterministic damage) provides the value of the deterministic "damage factor" *(light, moderate,* or *severe)* at a particular point in question. The damage factor is the ratio of the repair cost to the replacement cost for a particular type of structure, and the three damage levels are defined in the same way as those for probabilistic damage as described in Section 6.5.3.2.

SECTION 7

CONSEQUENCE

The commands under Consequence enable the user to calculate (rollup) total numbers of persons affected by technological and natural hazards and numbers of persons, housing and infrastructure assets at risk to the effects of such hazards. The choices under the Consequence command are illustrated in Figure 119.

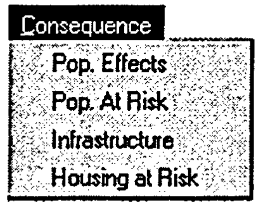


Figure 119. Consequence assessment options.

The user may choose:

Pop. Effects to calculate the expected population affected by casualty-producing environments or residence damage. The user has the option of calculating the affected population using either a Point, Grid or Polygon data bases;
Pop. At Risk to calculate the total number of persons within hazard areas. At present this option is available only with Point and Grid data bases;
Infrastructure to calculate the number of assets, such as hospitals, airports, radio stations, etc., within hazard areas;
Housing at Risk to calculate multi-family, single-family and mobile homes within hazard areas.

Not all hazards calculated by CATS may be used with Consequence commands. Only those hazards, loaded in the active view, for which casualty probabilities or, in the case of natural hazards, damage probabilities, are calculated may be used to calculated Population Effects. However, Infrastructure assets in hazard areas may be calculated for nearly all hazard types. Table 3 summarizes the CATS hazard model and currently valid data rollup combinations.

Table 4. Hazards for which consequences may be calculated.

Model	Pop. Effects Point Rollup	Pop. Effects Grid & Polygon Rollup	Pop. At Risk Point & Grid Rollup	Infrastructure Rollup	Housing at Risk Rollup
Rap. Haz. Asses.					
TIM	No	No	Yes	Yes	Yes
Chem/Bio Wpns	Yes	Yes	Yes	Yes	Yes
Rad. Wpn	No	No	Yes	Yes	Yes
Nuclear Wpn	Yes	Yes	Yes	Yes	Yes
High Explosive	No	No	Yes	Yes	Yes
Hazard Area	No	No	Yes	Yes	Yes
High Explosive	No	No	Yes	Yes	Yes
NAERG	No	No	Yes	Yes	Yes
ATP-45	No	No	Yes	Yes	Yes
D2PC	No	No	Yes	Yes	Yes
ALOHA	No	No	Yes	Yes	Yes

Model	Pop. Effects Point Rollup	Pop. Effects Grid & Polygon Rollup	Pop. At Risk Point & Grid Rollup	Infrastructure Rollup	Housing at Risk Rollup
CHAS – Fallout, Biological & Chemical Haz.	Yes	Yes	Yes	Yes	Yes
CHAS – Initial Radiation	Yes	Yes	Yes	Yes	Yes
CHAS – Blast & Thermal Haz.	No	No	Yes	Yes	Yes
HPAC-Nuclear Effects Prob.	Yes	Yes	Yes	Yes	Yes
HPAC-Nuclear Hazards	No	No	Yes	Yes	Yes
HPAC - Bio & Chem Effects Prob.	Yes	Yes	Yes	Yes	Yes
HPAC - Bio & Chem Hazards	No	No	Yes	Yes	Yes
HPAC – AVS Import Probabilities & Hazards	No	No	Yes	Yes	Yes
OSSM	No	No	No	No	No
Hurricane- Probabilistic	Yes	No	Yes	Yes	Yes
Hurricane-Deterministic	No	No	Yes	Yes	Yes
Earthquake-Probabilistic	Yes	No	Yes	Yes	Yes
Earthquake-Deterministic	No	No	Yes	Yes	Yes
Surge	No	No	Yes	Yes	Yes

7.1 DATA BASES.

CATS uses three different types of demographic data, Point, Grid and Polygon, in its population effects rollup calculation. All pertain to a residential, i.e. "night time" population. Not a "day time" or "at work" population. Each has a different spatial resolution. Some allow breakout of population data according to other factors, such as housing type, state/county of residence, etc. In general it is best to use Point data with large hazards and Polygon data with small hazards in CONUS. Grid data are the only worldwide data base in CATS and have adequate resolution for use with all hazard types.

7.1.1 Point Population and Housing Data.

Point data are based on the 1990 United States Census and contain data applicable only to the Contiguous Continental United States (CONUS). Point data represent the entire population in a given census block group as existing at a single point, located at the centroid of that census block group. Point population data carry with them additional demographic information that is used in CATS consequence assessment to differentiate persons by state, county, place and housing type. Point population data are routinely displayed in a CATS View of CONUS, represented by the "running person" symbol in the View shown in Figure 120. The population icon is not displayed in the active View unless the scale is 1 to 200,000 or less.

7.1.2 Grid Population Data.

Grid data are available in CATS for the entire world. These data are created on a 0.5 minute (~ 0.92 km) regular grid and are distributed with CATS451, as follows:

- **CONUS** - Contiguous Continental United States, installed with CONUS data installation option
- **World** – All countries, including the Continental United States, installed with World data installation option

7.1.3 Polygon Population Data.

Data in polygon format are available for the Contiguous Continental United States (CONUS). These data are developed from the 1990 Census data, as is the case for the point data. Polygon data are available in two forms, by Census Tract and by Census Block Group. A Tract is comprised of multiple block groups, therefore the Block Group data has the higher resolution of the two. The Block Group data are provided on a state-by-state basis, while the Tract data are provided in a single file for the entire CONUS.

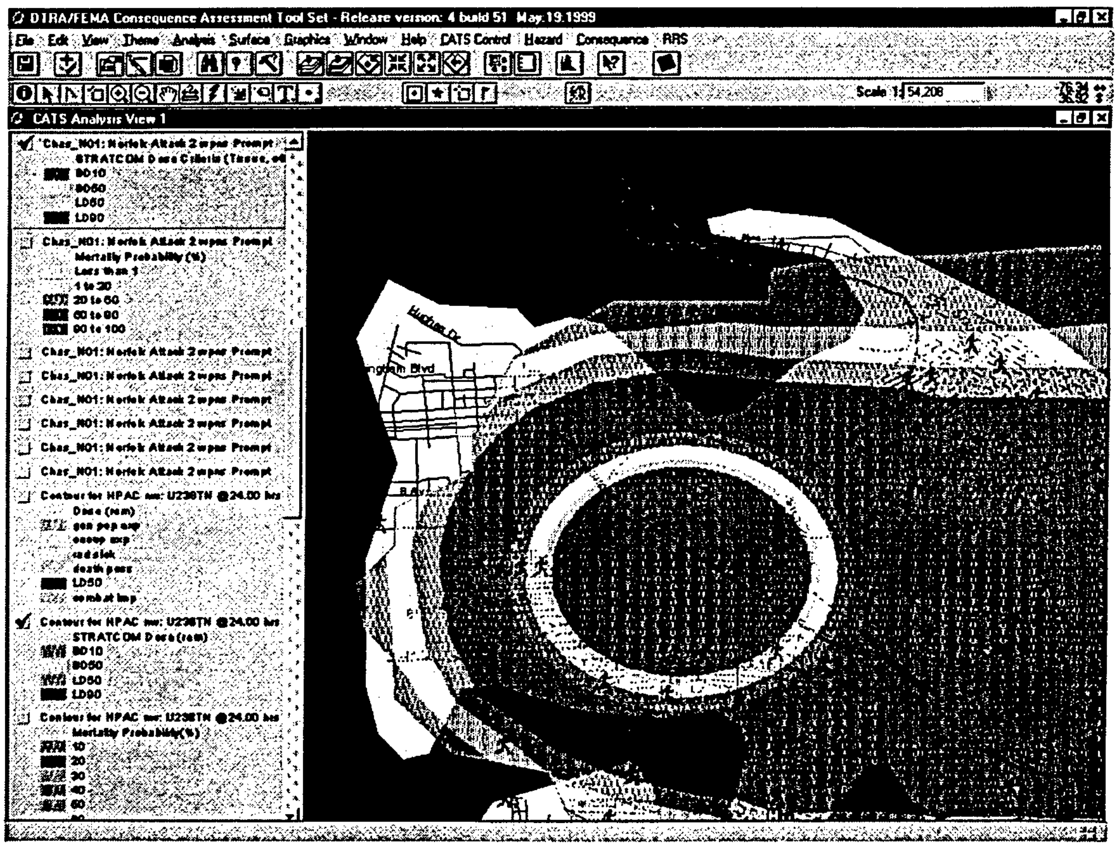


Figure 120. CATS View, showing hazard contours and point population data.

7.1.4 Infrastructure Data.

Infrastructure data are made available for use in CATS by the Federal Emergency Management Agency (FEMA). A list of the infrastructure data categories that may be associated with hazards in CATS is provided in Table 5. Each category contains entries having multiple descriptive fields. An example of the information associated with an entry is shown in Figure 121. The example illustrates the information available to describe a single hardware store, its name and address, telephone number, number of employees, annual sales, etc. These data are routinely updated. The updates are made available to CATS users through the Defense Threat Reduction Agency (DTRA).

Table 5. Infrastructure categories

Nuclear Reactors	NATURAL GAS STORAGE	SOFTDRINKS
AIRPORTS <= 5000 FT	NATURAL GAS PLANTS	SPORTING GOODS
AIRPORTS	CONSTRUCTION MATERIALS	WATER SUPPLY
HELICOPTER PADS	DEPARTMENT STORES	WHOLESALE GROCERY
AIR FLIGHT SERVICE STATIONS	ELECTRICAL APPLIANCES	DRUGS
VA CEMETARY SITES	ELECTRONIC PARTS	ELECTRO MEDICAL EQUIPMENT
CHEMICAL PLANTS	FABRIC MILLS	MEDICAL HOSPITAL SUPPLY
EBS AM-FM-TV EMP	FURNITURE STORES	OPTHALMIC GOODS
NETWORK TV	HAND TOOLS	PHARMACEUTICAL PREPS
PBS AM-FM,TV ALL	HARDWARE	SURGICAL APPLIANCES
COMUNICATIONS NODES	INDUSTRIAL MACHINERY	SURGICAL MEDICAL
WATER SUPPLY DAMS	LUMBER BUILDING MATERIALS	XRAY APPARATUS
IRRIGATION DAMS	LUMBER PLYWOOD	FEMA REGIONS & STATES
COAL MINES	ICE MANUFACTURER	RRS Mobility Sites
COKE PLANTS	MOTORS GENERATORS	VA HOSPITALS
ELECTRIC PWR PLANTS	PLASTIC BOTTLES	HOSPITALS
ENERGY IMPORT FACILITIES	RADIO TELEPHONE EQUIPMENT	1990 HOUSING BY ZIP CODE
OIL REFINERIES	RADIO TV COMMUNICATIONS	RRS Runways
TANK FARMS	SANITARY PAPER PRODUCTS	RRS Airports
STRATEGIC RESERVE	SOAP DETERGENTS	DCW Airports

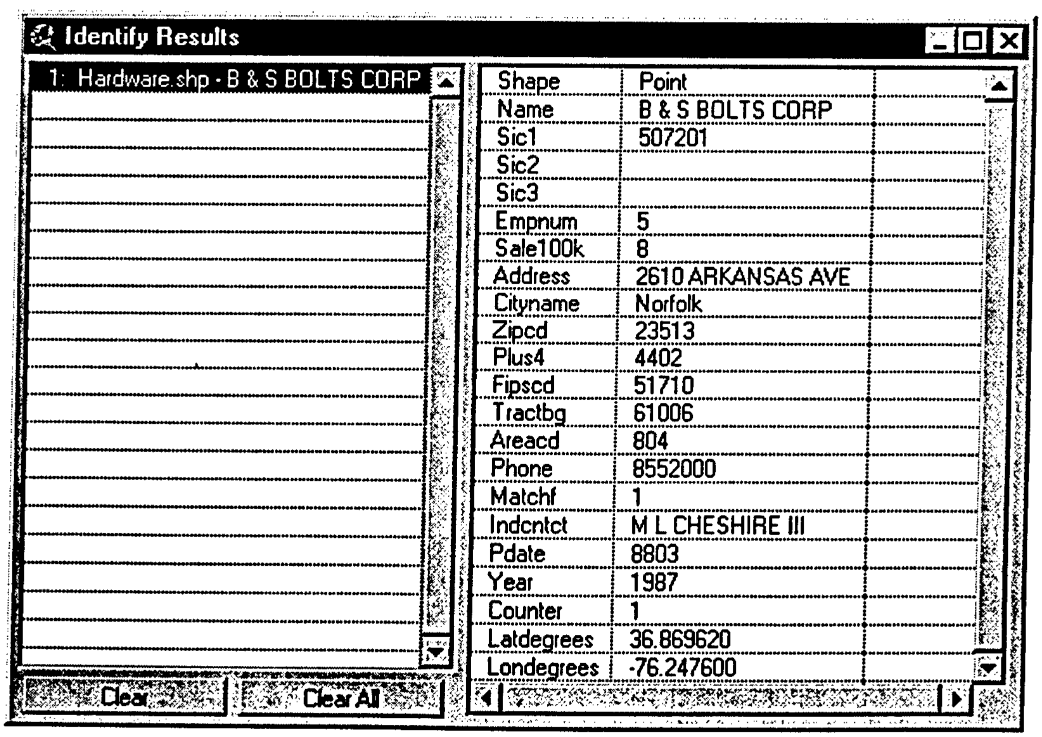


Figure 121. Infrastructure data base information example.

7.2 POPULATION EFFECTS.

Select *Pop. Effects* in the **Consequence** command menu to obtain the total number of persons suffering effects from exposure to a previously-calculated hazard. Effects are the product of a population at a location or in an area segment, multiplied by probability of effect, summed over all locations covered by effect footprint. A menu like that illustrated in Figure 122 will appear, containing a list of all qualified hazards as indicated in Table 3, i.e., those including an effects probability field in their data base file. Select the desired hazard and then select the OK button.

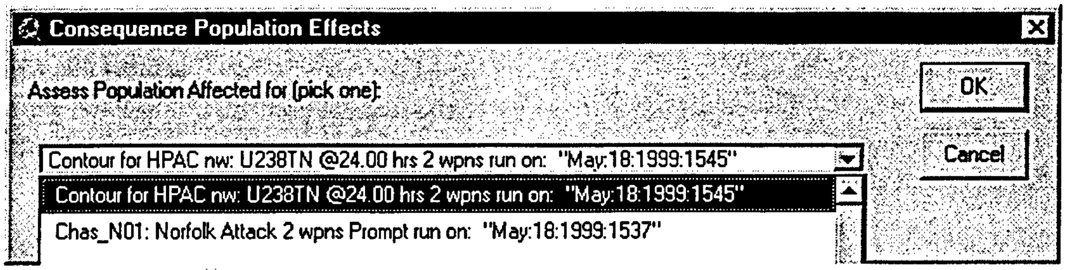


Figure 122. Population Effects hazard selection.

The *Pop. Effects* command calculates all available casualty types for each hazard as follows:

- Nuclear Fallout Radiation -Mortality.
- Nuclear Initial Radiation - Mortality.
- Military Chemical Agents - Mortality, Incapacitation, Visual Impairment, Threshold for Symptom Onset.
- Military Biological Agents - Mortality, Incapacitation.
- Hurricanes - Persons affected by damage to Single Family (SF), Multi-Family (MF) and Mobile (MH) Homes, Probabilistic or Deterministic.
- Storm Surge - Persons affected by damage to Single Family (SF), Multi-Family (MF) and Mobile (MH) Homes.
- Earthquakes - Persons affected by damage to Single Family (SF), Multi-Family (MF) and Mobile (MH) Homes, Probabilistic or Deterministic.

After selecting the desired hazard the user is prompted to select a demographic data base, as illustrated in Figure 123.

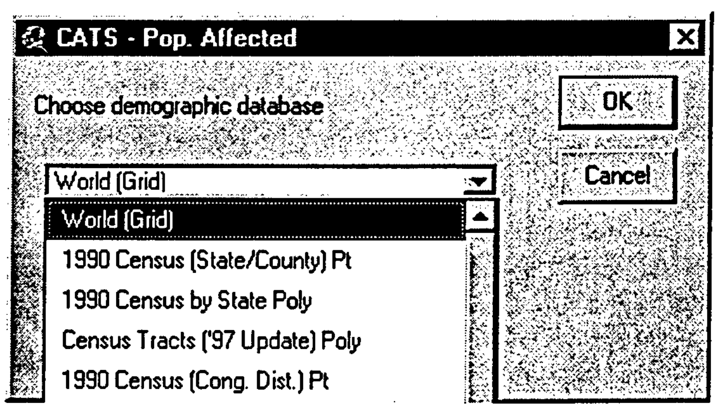


Figure 123. Demographic data base menu for Population Effects Rollup.

There are a number of caveats and recommendations associated with the Consequence/Pop. Effects options, as follows:

- Rollups using Point data are not restricted by state boundaries.
- Rollups using 1990 Census by State Polygon data must be performed on a state-by-state basis.
- The results obtained with Point, Grid and Polygon data are similar for large hazards, such as nuclear weapons fallout and biological agent plumes.
- The results obtained with Grid and Polygon data are more accurate than those obtained with Point data for small hazards, such as plumes of military chemical agents or toxic industrial materials.

7.2.1 Population Effects Point Rollup (CONUS Only).

A Population Effects Point Rollup for a specific health effect consists of the product of multiplying the United States 1990 census block group population, assumed to be located at the block group area centroid, by the probability of effect at the same location, summed over all census block groups subject to the hazard.

Perform a point population rollup by selecting the ***Consequence/Pop. Effects*** command sequence. As illustrated previously in Figure 122, the user is provided with a choice of qualified hazards available in the active View. Select a CONUS hazard and then select the 1990 census demographic database denoted as Point (Pt) data, as illustrated in Figure 123. Selecting other than a CONUS hazard and attempting a rollup with 1990 Census data will simply return a zero effects value.

```
rollup0.pop - Notepad
File  Edit  Search  Help
Population Affected (Census Point Data)
Computed Against: Contour for HPAC nw: U238TN @24.00 hrs 2 wpns

     Statename                      Countyname                      Mortality
===================  ======================================  ============
VIRGINIA             NORFOLK(IC)                                    78466
VIRGINIA             VIRGINIA BEACH(I                               42328
TOTAL                                                              120794
```

Figure 124. Population affected report, point state/county option.

The results are displayed automatically in a Notepad text box illustrated in Figures 124 and 125. The Notepad file may be renamed and saved. The first two lines in the box confirm the population data and hazard theme selected. Values are then given for each casualty type associated with the hazard. In the case shown, a fallout hazard, the only type of casualty calculated is mortality. The additional demographic data from the 1990 census carried with the point population data allows the consequence assessment to differentiate numbers affected according to a variety of criteria. The user may select either of two point rollup differentiation options, as follows:

```
rollup1.pop - Notepad
File  Edit  Search  Help
Population Affected (Census Point Data)
Computed Against: Contour for HPAC nw: U238TN @24.00 hrs 2 wpns

     Statename                       CongDis                        Mortality
===================  ======================================  ============
VIRGINIA             02                                            120794
TOTAL                                                              120794
```

Figure 125. Population affected report, point congressional district option.

- **State/County** - Differentiates between persons affected based on State and County (Figure 124)
- **Congressional District** - Differentiates between persons affected based on Congressional District (Figure 125)

In the case of technological hazards, specifically those associated with NBC weapons, the number affected is the product of the probability of the effect and the total number of persons exposed. Further, because all types of effects from NBC weapons do not manifest themselves simultaneously, the number affected is inclusive, going from high to low levels of effects, i.e., the number of persons suffering incapacitation includes the number that die.

In the case of probabilistic natural hazards the number affected is the product of the probability of a particular level of damage to a specified housing type and the number of persons in that housing type. Unlike technological hazards, it is assumed that all types of effects from natural hazards do manifest themselves simultaneously. Therefore, the number affected a specific level of damage is exclusive of those affected at any other level, i.e., the total number of persons affected in the mobile homes housing type is the sum of those affected at the light, moderate and severe levels.

In the case of deterministic natural hazards the number affected is that included between the limits of the effects severity contours, i.e. the number of persons affects at a moderate damage level does not include those affected at the severe damage level. The population considered in the deterministic hazard effects calculation depends on the structure type. In the case of single family (SF), multi-family (MF) and mobile homes (MH), only the number of persons residing in such structures is considered in determining the number affected. In the case of all other structure types the entire population is considered, i.e., the damage to Bank buildings in a given area is assumed to affect all local residents.

Figures 124 and 125 illustrate the results of a point population rollup for a fallout radiation hazard. As shown in Figure 120 that hazard typically intersects many population data points. In the case of a chemical hazard, particularly from a point source, the hazard footprints for casualties of all types are often very small, a few hundreds if not tens of meters in length and width. Therefore, as noted previously, it is not unusual that these footprints will fail to intersect a single population point, which may be many hundreds of meters and in some cases kilometers apart. Thus, the point roll up option is most appropriate for hazards with large footprints, such as those associated with nuclear or biological events, earthquakes and hurricanes, not those associated with chemical releases, unless the hazard is large and cuts across state boundaries.

7.2.2 Population Effects Grid Rollup.

Perform a point population rollup by selecting the Consequence/Pop. Effects command sequence. As illustrated previously in Figure 120, the user is provided with a choice of qualified hazards available in the active View. Select a hazard and then select the appropriate grid demographic data base. Attempting a rollup with a hazard outside the selected grid data domain will result in an error message.

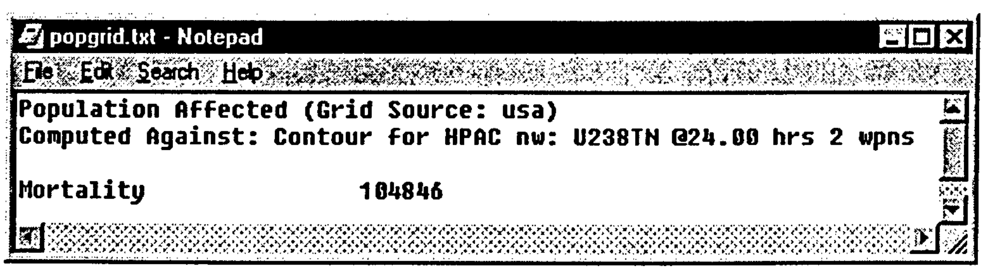


Figure 126. Population affected report, grid option.

The results of a population effects grid rollup are displayed automatically in a Notepad text box illustrated in Figure 126. The Notepad file may be renamed and saved. The first two lines in the box confirm the population data and hazard theme selected. Values are then given for each casualty type associated with the hazard. In the case shown, a fallout hazard, the only type of casualty is mortality. Note that population effect values obtained from grid and point (Figure 125) population data bases are different from each other, due primarily to population data resolution and to a lesser extent to disagreements between the two population distributions.

7.2.3 Population Effects Polygon Rollup

Populations effects assessment may be performed using two forms of polygon data, Tract data and Block Group data, as illustrate previously in Figure 123. The Tract data cover all of CONUS and have been updated to 1997, however, they provide less spatial detail than do the Block Group data, which are organized on a state-by-state basis and taken directly from the 1990 Census. Tract data are loaded as part of CATS static data. State Block Group data are provided on a separate CDROM and may be used directly from the CDROM or copied to the hard disk for faster performance.

A Population Affected Polygon Rollup for a specific health effect consists of the convolution of the probability of effect distributed over a census tract or block group with a population assumed to be uniformly distributed within the tract or block group area, summed over all census block groups subject to the hazard. The convolution is accomplished by stratified sampling of the distribution of the product of effect probability multiplied by population density, with a correction to insure population conservation. The sampling is performed on a uniform grid.

Polygon population rollups are available for use with technological hazards only and are recommended for use with chemical hazards. In order to perform a polygon population rollup using the 1990 Census by State Poly data, the user should first enter the location of that data base in either the CATS Menu/CATS Preferences/CATS System Settings in the Project Screen or in CATS Control/CATS Preferences/CATS System Settings. The State polygon population data base is very large (563 MB) and is supplied on a separate CDROM, so that the user may designate the data location and not have to load the data on the same hard drive as the rest of the CATS system.

Begin a polygon population rollup by selecting the ***Consequence/Pop. Effects*** command sequence. A screen similar to that illustrated previously in Figure 122 will appear to provide the user with a choice of qualified hazards available in the active View. Select a hazard and in the next menu select a population data set having a Poly designation. Select the state polygon data and a list of states subject to the hazard will be provided in a file service screen, as illustrated in Figure 127. Select the state for which the effects assessment is desired. Repeat this sequence for each state of interest. Assessment using the tract polygon is performed for any CONUS location and do not differentiate by state.

If the user selects the state polygon data and has not properly set the location of those data in CATS SYSTEM SETTINGS, under CATS Preferences in CATS Menu (Project Screen) or CATS Control (View Screen), the state abbreviation shape file names will not appear. If this is the case, cancel out of this screen, set the location of the polygon population data and begin the polygon population rollup process again.

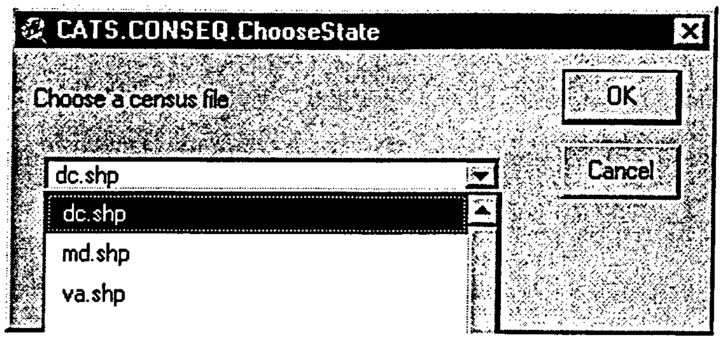


Figure 127. Select a State polygon population data file for a State touched by the selected hazard.

The results of a population effects grid rollup are displayed automatically in a Notepad text box illustrated in Figure 128. The Notepad file may be renamed and saved. The first two lines in the box confirm the population data and hazard theme selected. Values are then given for each casualty type associated with the hazard. In the case shown, a fallout hazard, the only type of casualty is mortality. The population affected calculated with polygon data and shown in Figure 128 is the result of the same hazard as that used to produce the population affected value in Figure 126. Note that the values are nearly identical. In the case of a chemical hazard, particularly from a point source, the hazard used to calculate population affected by these two means is often very small, and the values calculated by the two methods may be quite different. Thus, the polygon and grid roll up options, rather than the point option, are the most appropriate for hazards with small footprints, such as those associated with chemical releases.

In the case of rollups involving technological hazards, the number of affected persons is inclusive, proceeding from the most severe to the least severe effects, i.e., the number of persons exhibiting threshold symptoms includes those who will exhibit visual impairment, incapacitation and death.

Note that the Polygon rollup process is different from the "select feature using graphic" (roping) that may be performed manually in ArcView. The roping process, applied to population polygons would obtain the entire population of any polygon, a part of which falls within the specified area, whereas the Polygon roll up process pro-rates the population in a given polygon to obtain only that within the hazard tile area.

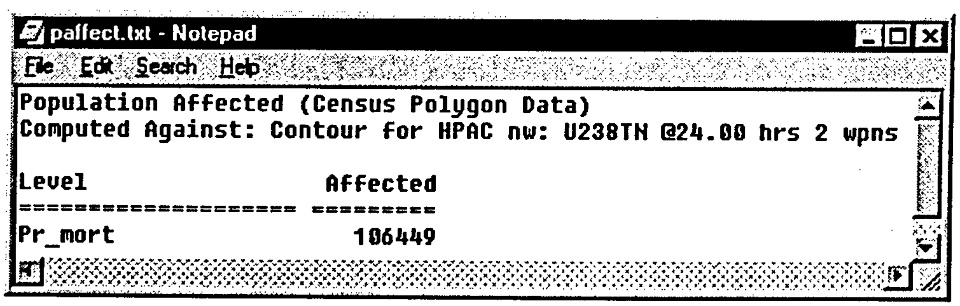
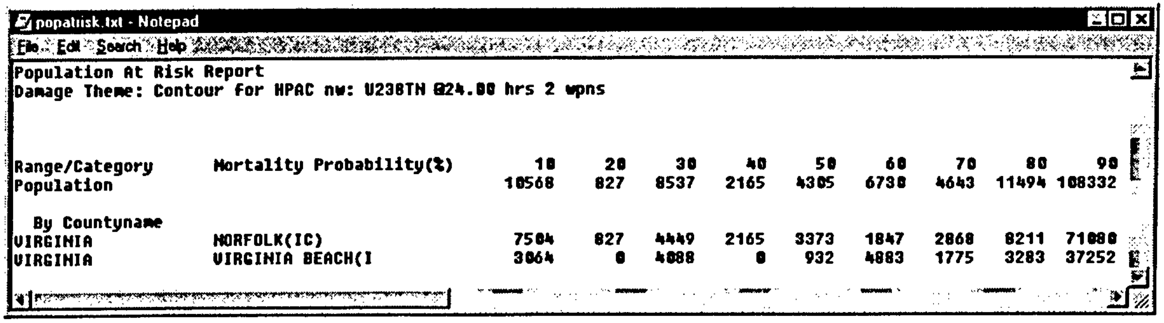


Figure 128. Population Affected report, state polygon option.

7.3 POPULATION AT RISK.

Perform population at risk rollup by selecting the *Consequence/Pop. At Risk* command sequence, as illustrated in Figure 119. A screen similar to that illustrated in Figure 122 will appear, providing the user with a choice of qualified themes available in the active View. Themes available for use in population at risk rollups include hazard distributions and probability distributions, as well as hazard areas, such as those constructed by ATP-45 and NAERG. Population at risk rollup calculates the total number of persons included within the boundaries or contours of the chosen theme. It does not calculate the number of persons actually affected within those

boundaries or contours. Unlike population affected rollups, at-risk rollups do not differentiate between populations in various housing types, rather, the number at risk is taken from the entire population.



```
popatrisk.txt - Notepad
File Edit Search Help
Population At Risk Report
Damage Theme: Contour for HPAC nw: U238TN @24.00 hrs 2 wpns


Range/Category     Mortality Probability(%)      10    20    30    40    50    60    70    80     90
Population                                     10568   827  8537  2165  4305  6730  4643 11494 108332

  By Countyname
VIRGINIA           NORFOLK(IC)                  7504   827  4449  2165  3373  1847  2868  8211  71080
VIRGINIA           VIRGINIA BEACH(I             3064     0  4088     0   932  4883  1775  3283  37252
```

Figure 129. Population at Risk Report.

After choosing the theme for which a determination of population at risk is desired, the point population data base will be queried for persons under each contour of the chosen theme, as it currently formatted in the View table of contents. An example for the case of a fallout radiation hazard is illustrated in Figure 7-129 (Note that the format of this report has been altered for brevity). This shows the total number of persons between each contour. Thus, the total number of persons at risk to mortality, i.e., for whom death is possible, as a result of being exposed to fallout radiation for 24 hours is 157,601. This number is the sum of the number of persons included in the band of interest plus those in all bands indicating more severe consequences. The total number of mortalities determined for this case using the same population database is 120,794, as shown in Figure 124 as an example of Population Affected Rollup.

7.4 INFRASTRUCTURE.

Determining the number of infrastructure assets, such as hospitals or communications hubs, included within a hazard area is called an Infrastructure Rollup. Perform an infrastructure rollup by selecting the ***Consequence/Infrastructure*** command sequence. A screen similar to that illustrated in Figure 122 will appear in order to provide the user with a choice of qualified hazards available in the active View. After selecting a hazard, the user is presented with a choice of rollup options, as illustrated in Figure 130. The first option is Matrix; the second is Detailed. Choose Matrix to determine the number of infrastructure assets of a particular type (to be chosen later) within the bounds of the hazard contour. Choose Detailed to also receive a list of names of each of the assets.

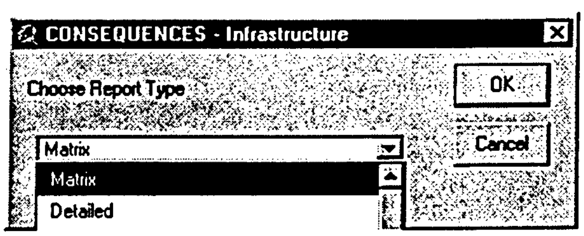


Figure 130. Infrastructure rollup options.

Note: The list of asset names may be very large. Therefore it is recommended that the user first use the Matrix option to determine the total number of assets affected in any one category.

After choosing either Matrix or Detailed, select one or more infrastructure assets of interest from the list of themes presented, as illustrated in Figure 131.

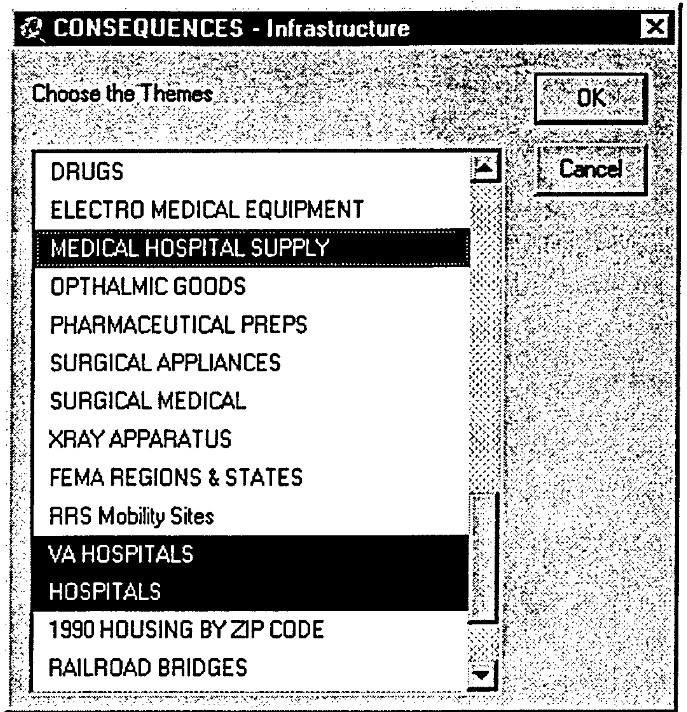
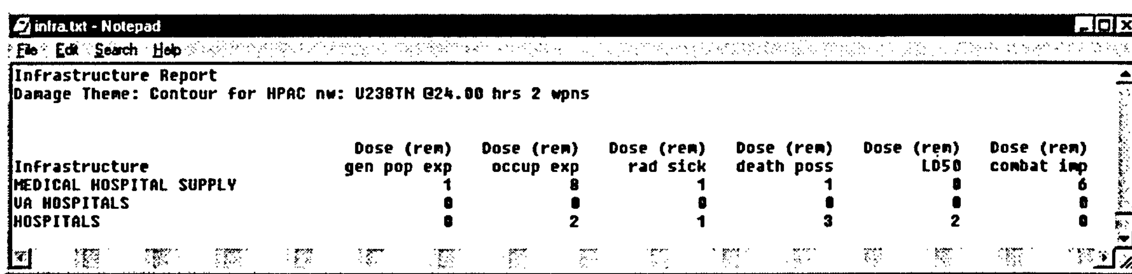


Figure 131. Infrastructure asset (theme) selection.

The results of a Matrix rollup for Medical Hospital Supply and both Hospitals and VA Hospitals for the case of the fallout radiation hazard shown in Figure 121 are shown in Figure 132. The report lists the type of asset and the number under each contour. In this case seventeen Medical Hospital Supply sites were found. Eight Hospitals and no VA Hospital were also found in the database.

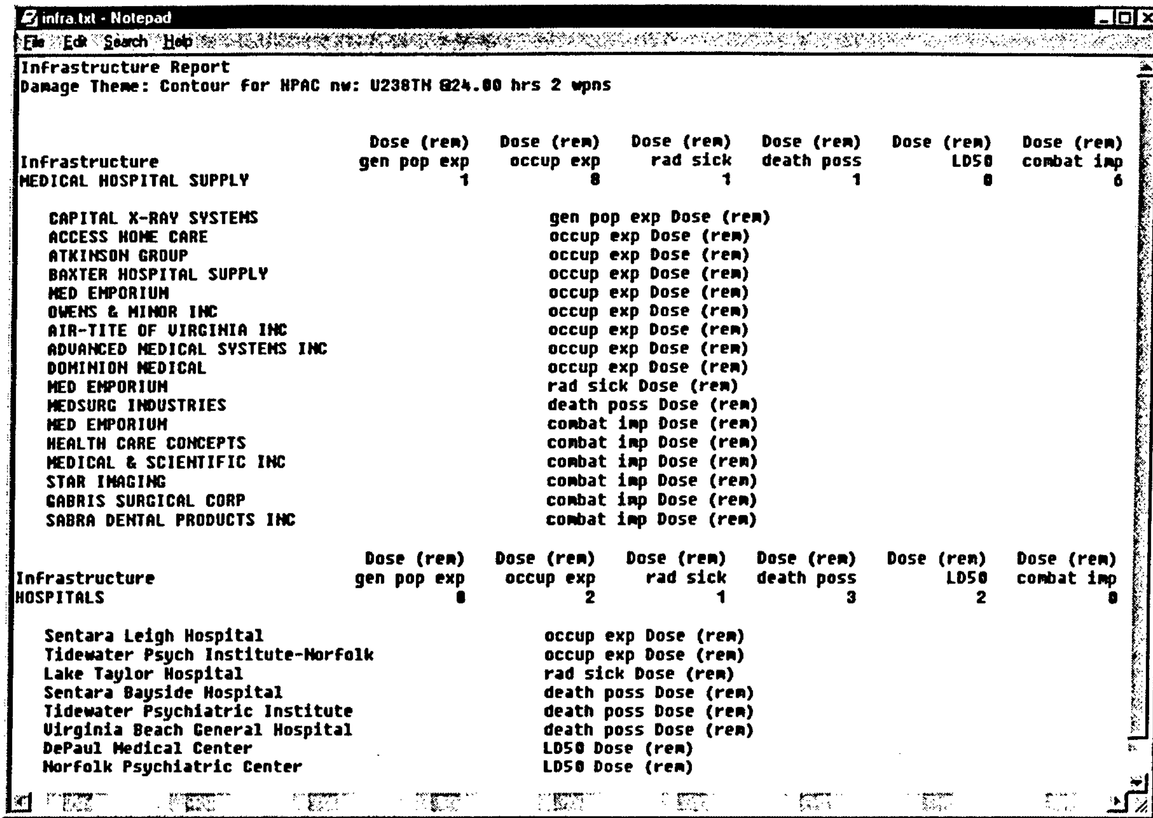

infra.txt - Notepad

Infrastructure Report
Damage Theme: Contour for HPAC nw: U238TN @24.00 hrs 2 wpns

Infrastructure	Dose (rem) gen pop exp	Dose (rem) occup exp	Dose (rem) rad sick	Dose (rem) death poss	Dose (rem) LD50	Dose (rem) combat imp
MEDICAL HOSPITAL SUPPLY	1	8	1	1	0	6
VA HOSPITALS	0	0	0	0	0	0
HOSPITALS	0	2	1	3	2	0

Figure 132. Infrastructure Report, matrix.

The results of an infrastructure Detailed rollup for the same hazard and for Hospitals and Medical Hospital Supply are shown in Figure 133. The results contain the type of asset and the number under each contour, plus a list of names of all included assets is also provided along with the hazard contour within which the asset resides.


infra.txt - Notepad

File Edit Search Help

```
Infrastructure Report
Damage Theme: Contour for HPAC nw: U238TN @24.00 hrs 2 wpns


                                   Dose (rem)  Dose (rem)  Dose (rem)  Dose (rem)  Dose (rem)  Dose (rem)
Infrastructure                     gen pop exp   occup exp    rad sick  death poss        LD50  combat imp
MEDICAL HOSPITAL SUPPLY                     1           8           1           1           0           6

   CAPITAL X-RAY SYSTEMS                       gen pop exp Dose (rem)
   ACCESS HOME CARE                            occup exp Dose (rem)
   ATKINSON GROUP                              occup exp Dose (rem)
   BAXTER HOSPITAL SUPPLY                      occup exp Dose (rem)
   MED EMPORIUM                                occup exp Dose (rem)
   OWENS & MINOR INC                           occup exp Dose (rem)
   AIR-TITE OF VIRGINIA INC                    occup exp Dose (rem)
   ADVANCED MEDICAL SYSTEMS INC                occup exp Dose (rem)
   DOMINION MEDICAL                            occup exp Dose (rem)
   MED EMPORIUM                                rad sick Dose (rem)
   MEDSURG INDUSTRIES                          death poss Dose (rem)
   MED EMPORIUM                                combat imp Dose (rem)
   HEALTH CARE CONCEPTS                        combat imp Dose (rem)
   MEDICAL & SCIENTIFIC INC                    combat imp Dose (rem)
   STAR IMAGING                                combat imp Dose (rem)
   GABRIS SURGICAL CORP                        combat imp Dose (rem)
   SABRA DENTAL PRODUCTS INC                   combat imp Dose (rem)

                                   Dose (rem)  Dose (rem)  Dose (rem)  Dose (rem)  Dose (rem)  Dose (rem)
Infrastructure                     gen pop exp   occup exp    rad sick  death poss        LD50  combat imp
HOSPITALS                                   0           2           1           3           2           0

   Sentara Leigh Hospital                      occup exp Dose (rem)
   Tidewater Psych Institute-Norfolk           occup exp Dose (rem)
   Lake Taylor Hospital                        rad sick Dose (rem)
   Sentara Bayside Hospital                    death poss Dose (rem)
   Tidewater Psychiatric Institute             death poss Dose (rem)
   Virginia Beach General Hospital             death poss Dose (rem)
   DePaul Medical Center                       LD50 Dose (rem)
   Norfolk Psychiatric Center                  LD50 Dose (rem)
```

Figure 133. Infrastructure report, detailed.

7.5 HOUSING AT RISK.

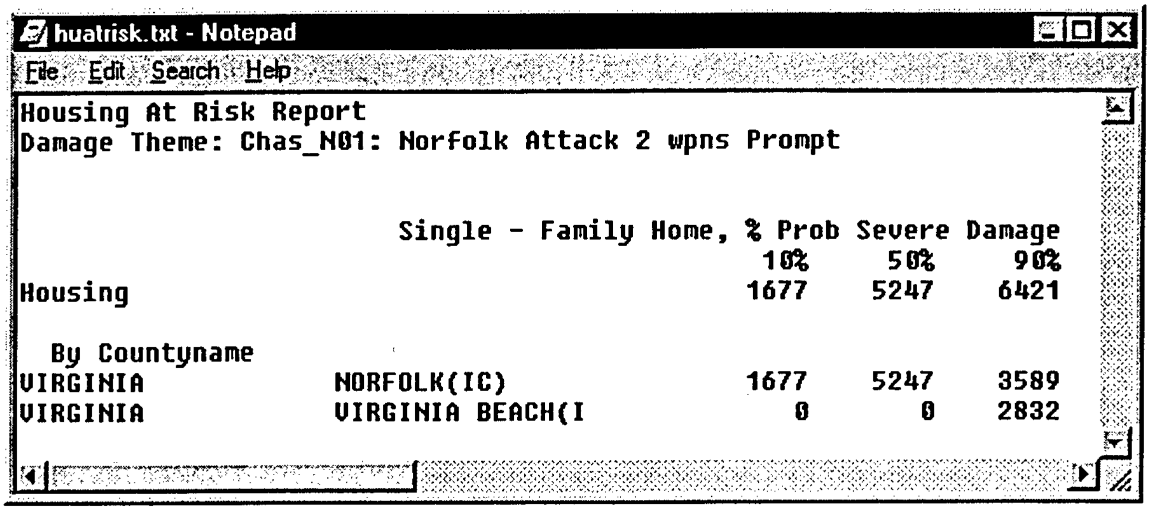
The 1990 Census data contain the number of persons occupying housing units in categories of single family, multi-family and mobile homes. The data also contain the number of such homes in the same categories. ***Housing at Risk*** allows the user to determine the total number of homes in an area subject to a specific hazard or consequence level.

After creating a hazard and loading it in the active view, select ***Housing at Risk*** from the **Consequence** Command bar. Select the desired hazard or consequence theme from the drop-down list provided. Note that the width of the list may be modified to read long theme names by placing the cursor at the right or left extent of the Consequence Housing at Risk window, obtaining a double-ended arrow cursor, depressing and holding the left mouse button and dragging the edge of the window left or right to obtain a new size. Likewise, the length of the drop down list may be modified by increasing the height of the window in a similar fashion.

Having selected a hazard or consequence theme, next select the desired demographic theme from the list provided in the next window. Note that all the available demographic themes are those associated with the 1990 Census. This limitation is caused by the fact that only the 1990 Census themes include the required housing data. The user is allowed the choice of the breakout of the data into subcategories, such as by state/county or by Congressional district.

If the user selects a hazard or consequence theme including a specific housing category, only that category will be used to determine the number of houses at risk. For example, Figure 134 illustrates a report of Single Family houses at risk to severe damage from the blast associated with nuclear weapons detonations. The theme contours include three levels of blast damage probability, 10, 50 and 90 percent. Since the postulated event includes multiple bursts, the houses at risk are spread over two counties.

If the user selects a hazard or consequence theme that does not include any reference to housing category, the Housing at Risk consequence assessment will provide the total number of houses of all types within the limits of each hazard or consequence theme contour.




```
Housing At Risk Report
Damage Theme: Chas_N01: Norfolk Attack 2 wpns Prompt


                        Single - Family Home, % Prob Severe Damage
                                                 10%      50%      90%
Housing                                         1677     5247     6421

  By Countyname
VIRGINIA            NORFOLK(IC)                 1677     5247     3589
VIRGINIA            VIRGINIA BEACH(I               0        0     2832
```

Figure 134. Housing at Risk report.

SECTION 8

RESPONSE, RESOURCES, AND SUSTAINABILITY (RRS) ANALYSIS

8.1 INTRODUCTION.

Response, Resources, and Sustainability (RRS) analysis provides emergency managers with answers to the following relief-support questions:

- What resources are needed to mitigate consequences of the disaster?
- What and where are the potential sources of relief supplies?
- To where should the resources be delivered (mobilization sites)?
- Where should roadblocks be placed to prevent unauthorized access?

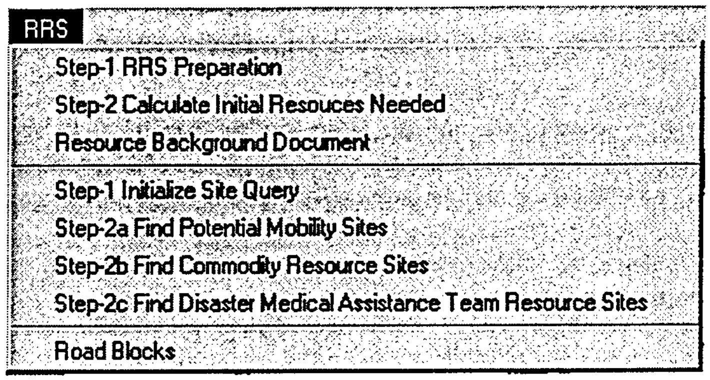


Figure 135. RRS main menu.

RRS analysis is divided into three sections, as illustrated in Figure 135, which shows the RRS main menu. The first section computes **Initial Resources** needed to support a population displaced by residential structure damage. The second section performs a **Site Query** to find locations to which the required resources from outside the region may be delivered (mobility sites) and where they may be obtained in or near the region (resource sites). The third section is **Roadblock**, which computes all locations required to interdict an area subject to a hazard or level of effect.

Initial resource and site query analyses are based on the extent of damage predicted by both natural and technological hazards and effects probabilities predicted by CATS. Table 6 below shows which models may be used with these tools and the population rollup method on which the RRS initial resource estimates are based. Roadblocks analysis can be used with any hazard, however, care must be taken not to choose too large a hazard or the shear number of streets can overwhelm the system in terms of run time and disk space.

Table 6. Hazards compatible with RRS tools.

Model	RRS Initial Resources	RRS Site Query
Hurricane Damage - Probabilistic	Yes (Point Rollup)	Yes
Hurricane Damage - Deterministic	No	Yes
Earthquake Damage - Probabilistic	Yes (Point Rollup)	Yes
Earthquake Damage - Deterministic	No	Yes
Storm Surge - Deterministic	No	Yes
Technological Hazards	No	Yes

8.2 CALCULATE INITIAL RESOURCES NEEDED.

RRS computes initial resources needed based on the number of persons affected by the hazard. Therefore the first step in determining the amount of these resources is to compute the number of persons subject to light, moderate and severe damage to residences in three categories: Single family homes (SF), Multi-family homes (MF) and Mobile homes (MH). This computation is based on the probabilistic damage computation. It differs from the population-affected rollup, using point data, described in the previous chapter only in the fact that it is performed for all three residence categories at once, to facilitate the remainder of the RRS analysis.

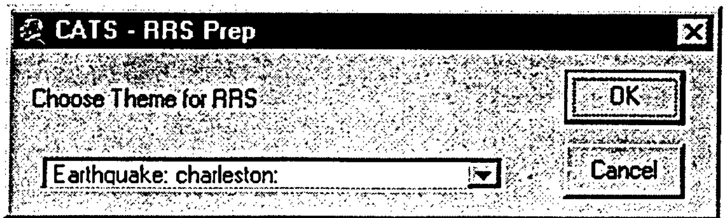


Figure 136. Choose a (natural) hazard.

Select Step-1 RRS preparation to compute the number of persons affected in all three residential housing types and at all three levels of damage severity. Select the desired natural hazard from those listed as shown in Figure 136. The hazards listed must have been calculated previously and displayed in the current view, as described in Section 6 of this report. Upon selection of the desired hazard RRS Preparation will run to completion without further input from the user. Because the area covered by natural hazards is typically very large this preparatory computation may take a few minutes. The user is notified when the computation is complete, as illustrated in Figure 137.

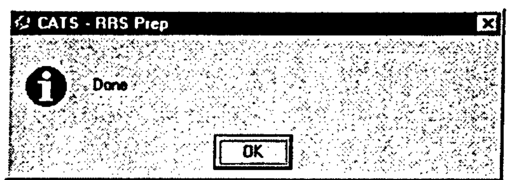


Figure 137. RRS Preparation completion notice.

Select Step-2 Calculated Initial Resources Needed to complete the resource calculation. The calculation may be performed for individual housing types or all housing types, as illustrated in Figure 138.

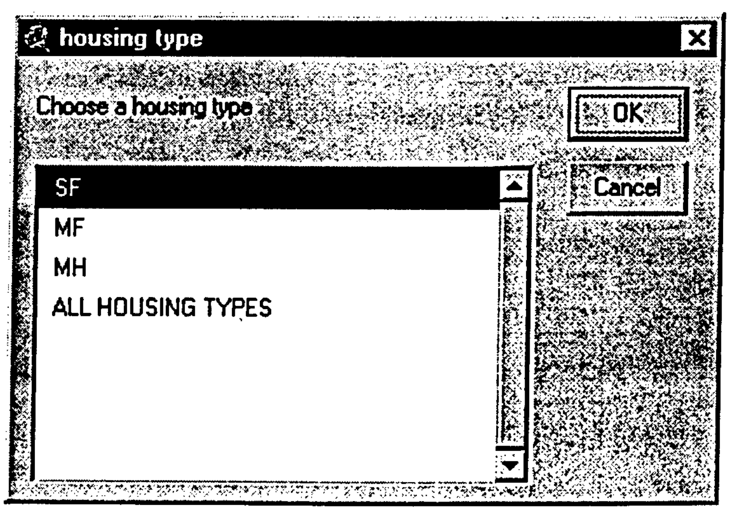


Figure 138. Select housing type.

Likewise, the calculation may be performed for a specific damage level or all damage levels, as illustrated in Figure 139.

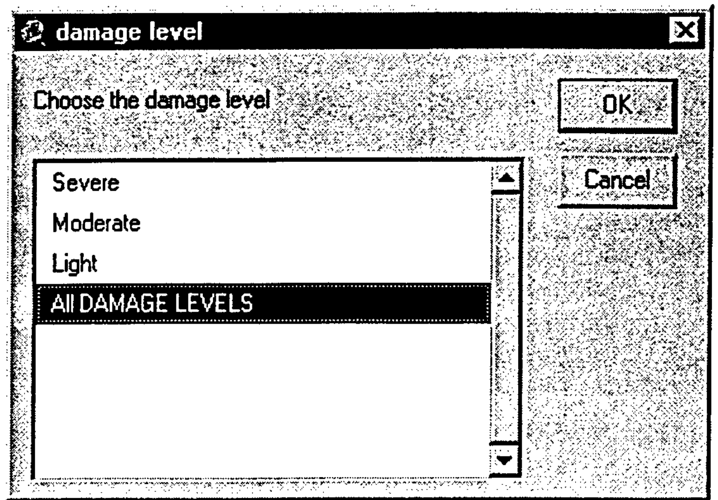


Figure 139. Select damage level.

Finally, as illustrated in Figure 140, the user selects the type of climate specific to the affected area. The climate is important because it affects certain types of relief supplies, such as ice.

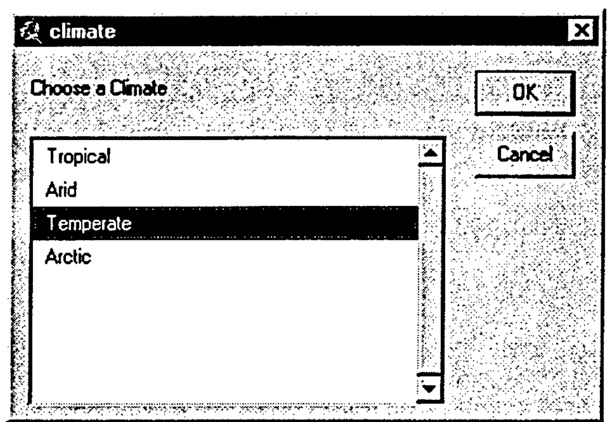
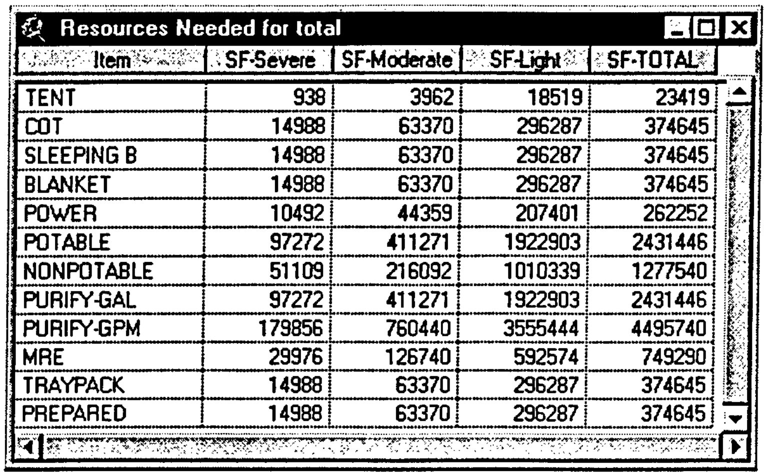


Figure 140. Select climate type.

An example initial resources needed computation is shown in Figure 141. The example pertains to support of persons affected by damage to Mobile Homes, caused by Hurricane Emily at all damage levels (light, moderate and severe), in a temperate climate. Calculation of initial resources required for relief support requirements is performed using a geo-spatial intersection of the U.S. Census block group data with the CATS probabilistic damage distribution, for persons at risk in the specific housing type selected earlier. At the centroid of each block group the population in the housing type being analyzed is multiplied by the probability of light, moderate, and severe damage. The values in each of the three housing types and three damage level categories are summed over all block groups affected to yield the total population at risk by category. Planning factors are then applied to obtain the required quantities of relief supplies. The results appear in a table as shown in Figure 141.

The initial relief supplies required by persons in homes subject to light, moderate and severe damage levels are all the same. Expendable supplies are sufficient for three days. After that period replenishment of expendable supplies may be required, particularly for persons in moderately or severely damaged structures.



Resources Needed for total

Item	SF-Severe	SF-Moderate	SF-Light	SF-TOTAL
TENT	938	3962	18519	23419
COT	14988	63370	296287	374645
SLEEPING B	14988	63370	296287	374645
BLANKET	14988	63370	296287	374645
POWER	10492	44359	207401	262252
POTABLE	97272	411271	1922903	2431446
NONPOTABLE	51109	216092	1010339	1277540
PURIFY-GAL	97272	411271	1922903	2431446
PURIFY-GPM	179856	760440	3555444	4495740
MRE	29976	126740	592574	749290
TRAYPACK	14988	63370	296287	374645
PREPARED	14988	63370	296287	374645

Figure 141. Initial resources needed, population in single family homes, hypothetical earthquake in Charleston, SC.

8.3 FIND MOBILITY AND RESOURCE SITES.

RRS analysis determines sources of the relief supplies and the locations of mobility sites to which they must be delivered. The process begins with Initialization. From the second section of the RRS main menu, choose Step-1 Initialize, as shown previously in Figure 135.

First, choose the damage theme for the structure type to be used in determining site locations, as shown in Figure 142 (the example shown is for a hypothetical Charleston, SC, earthquake damage to single family homes). This theme must be created previously to performing the RRS analysis, using one of the hazard computation options under the CATS Hazard command.

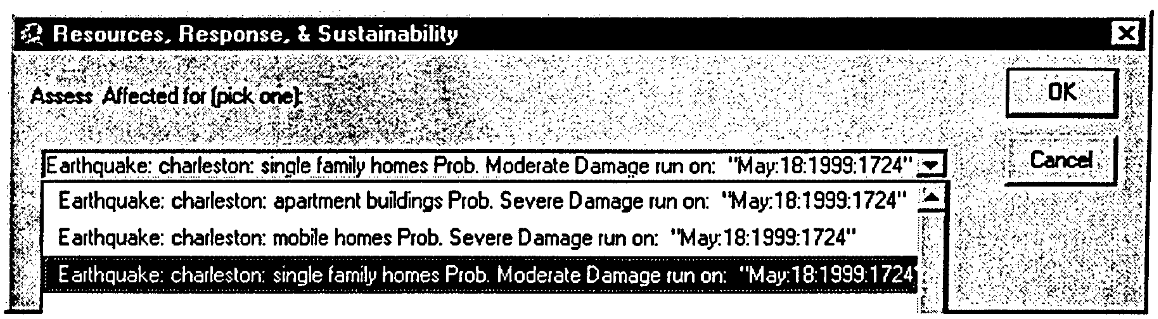


Figure 142. Navigate to the damage band theme generated by previously run hazard.

Next, the initialization process allows the user to establish criteria for selecting suitable mobilization (supply delivery) and resource supply sites, as illustrated in Figure 143 and described as follows:

- Aircraft type; choice is C-141 or C-130; default is C-141.
- Distance limit from the reference damage band; distance must be greater than zero miles; default is 100 miles (Reference damage band is established based on the highly damaged area exclusion preference; see text associated with Figure 144, below).
- Warehouse space (Federal facility with physical security measures in place); space must be greater than zero square feet; default is 4000 square feet.
- Verification of military landing rights; choice is Yes or No, default is Yes.

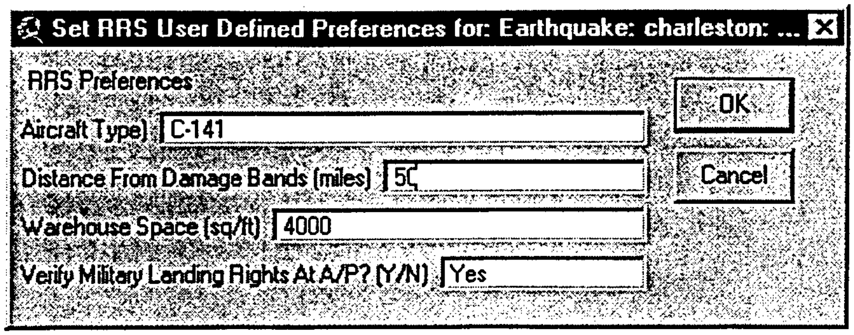


Figure 143. RRS initialization preferences.

Note: In this or subsequent RRS windows, data entry options may be obtained by entering a question mark (?) in the edit box of interest and clicking OK. This either provides choices for entry information or ranges for such input. However, upon completion the user will NOT be returned to the previous screen, but will move forward in the RRS input process.

Next, choose whether to exclude sites in highly damaged areas from the RRS mobility/resource site calculation, as shown in Figure 144.

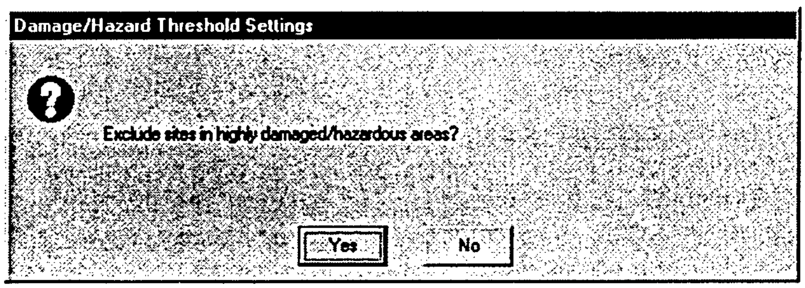


Figure 144. Decide whether to exclude mobility or resource sites in the damaged.

The impact of this choice is as follows:

- **Yes** - Causes RRS to determine the number of mobility or resource sites outside a reference damage band to the distance specified previously, as illustrated in Figure 143; the reference damage band is chosen from a list of those appearing in legend of the chosen hazard theme, as shown in Figure 145.

- **No** - Causes RRS to determine the number of mobility or resource sites within the hazard polygon having the highest level of hazard, damage or casualty probability and to a distance from that polygon specified as shown in Figure 145.

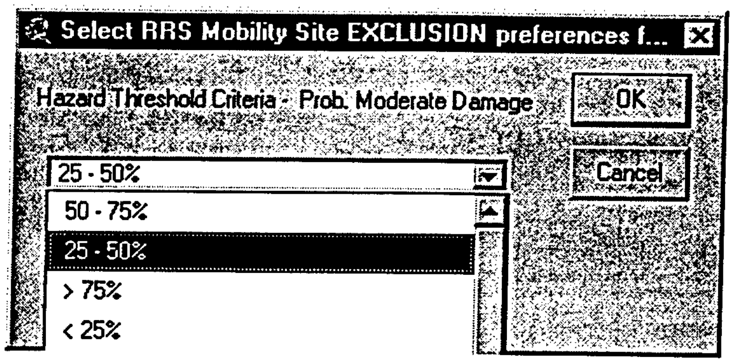


Figure 145. Enter minimum damage level and probability criterion to define exclusion region.

Upon completion of the initialization process, the user is provided with a message that initialization is **Done**. The user now has three choices within the RRS analysis process:

- Determine the locations of mobility sites,
- Determine the location of commodities sources, and
- Determine the location of sources that may provide commodities that support disaster medical assistance teams.

8.3.1 Find Potential Mobility Sites.

The Potential Mobility Site search can take considerable time, depending on the extent stipulated in RRS Preferences and on the speed and memory of the computer. The blue percent completion bar at the bottom of the View screen is an indicator that the calculation is progressing. When all possible sites are identified, the dialog shown in Figure 146 appears, prompting the user for input regarding a scoring algorithm. The scoring algorithm allows the user to associate the most appropriate mobility sites and airports, according to weighting criteria pertaining to their proximity to the hazard site, their amounts of warehouse space, and the availability of military landing rights.

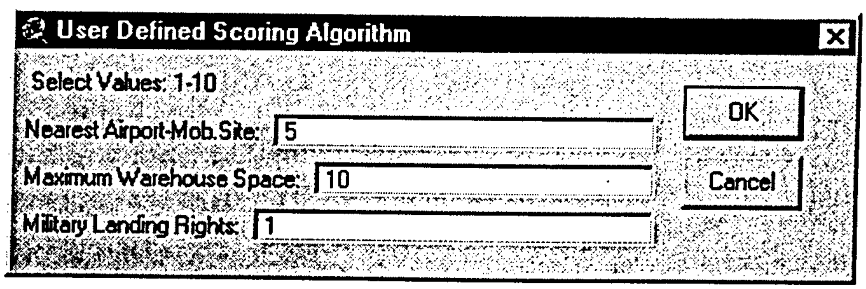


Figure 146. Apply user-defined scoring algorithm criteria.

Enter a value between one and ten for each of these quantities, where "1" indicates little importance and "10" indicates greatest importance. For example, if warehouse space is not a major consideration, but distance from the supply delivery site to his location is, enter "1" for warehouse space and "10" for nearest airport mobility site.

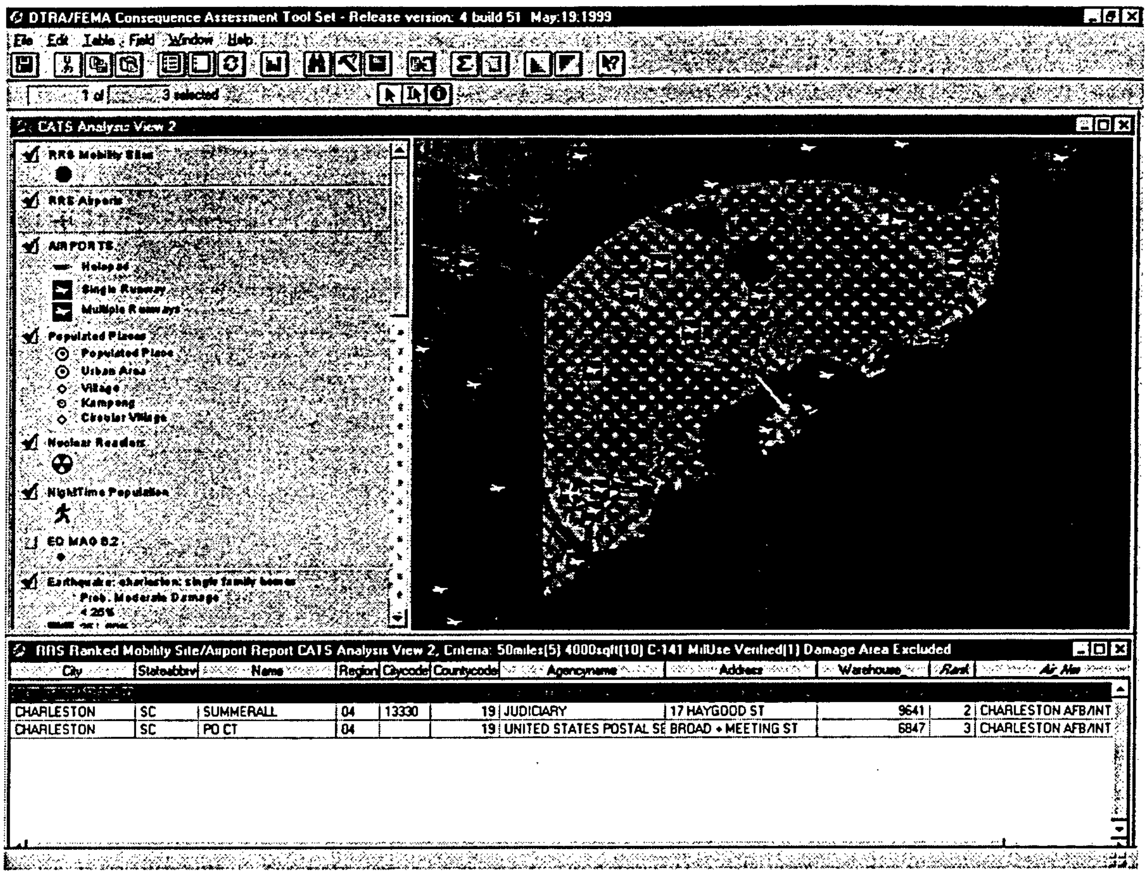


Figure 147. Display of candidate mobility sites and nearby airports.

After the user clicks OK, candidate mobility conforming to Initialize Site Query criteria are loaded and displayed in the active View, as illustrated in Figure 147. The optimum combinations of candidate mobility sites and airports, chosen according to the weighting criteria entered previously, are linked by green lines. The warehouse sites included in these optimum combinations are listed in the supporting table that appears below the View screen upon execution of the Find Potential Mobility Sites command. Using the cursor, select a warehouse of interest from the table and its icon will become highlighted in the View.

Find Potential Mobility Sites can be repeated as often as necessary, varying the weighting criteria as desired.

More detailed data regarding the warehouse and airport sites may be queried from the underlying database:

- Highlight (make active) the theme of interest (such as mobility sites)
- Click the Identify button in the ArcView Toolbar
- Click on a mobility site icon in the current View with the Identify Tool to obtain details.

Figure 148 displays example results of executing these steps.

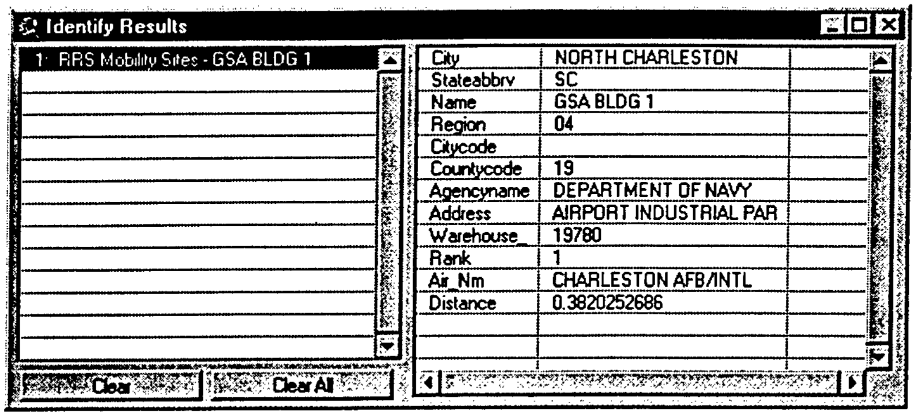


Figure 148. Using the identify tool to display detailed information about a mobility site.

The underlying databases detail the location, address, space and the agency point of contact for each mobility site. The same procedure can be used to obtain information about the airports selected by RRS. The airport data include the person point of contact and various details about the airport.

8.3.2 Find Commodity Resource Sites.

After performing Step-1 Initialize Site Query in the second section of the RRS command list, the user may choose Find Commodity Resource Sites from the command list to determine locations of sources for specific commodities. (Note: The initialization procedure needs to be performed only once for all subsequent analyses, unless it is desired to change the initialization criteria) Choose one or more types of commodities from the list provided, as illustrated in Figure 149. Choose a single or multiple types by clicking on the desired type with the cursor. To remove selected types, click on them a second time.

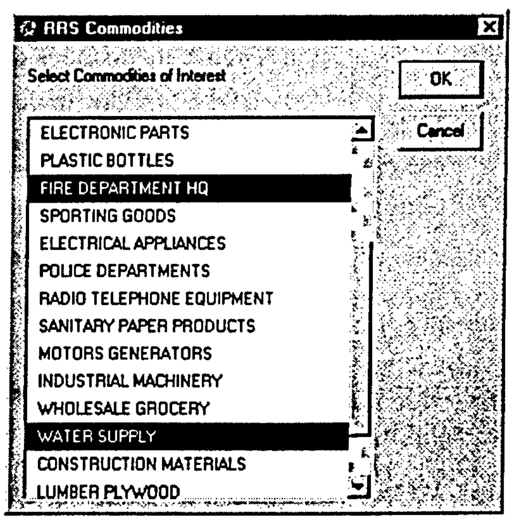


Figure 149. Select relief-supply sources for display in the current View.

After selecting the desired commodity type or types, those existing within the initialization distance criterion from the desired damage theme are loaded into the current View and displayed as shown in Figure 150, which illustrates the locations of fire department headquarters and water supplies in and around damage caused by a hypothetical Charleston, SC, earthquake.

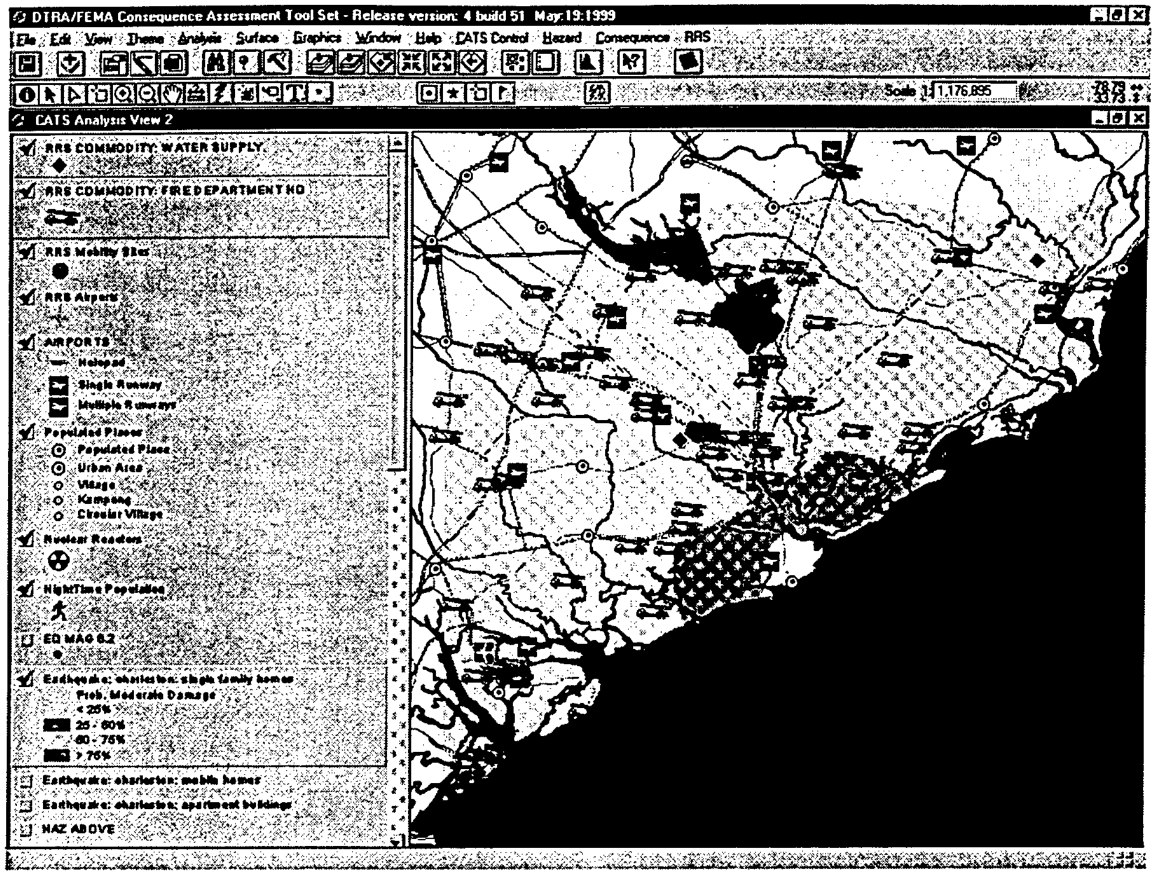


Figure 150. Display of selected commodities: Fire Department Headquarters and Water Supplies.

More detailed data regarding the Ice Manufacture and Water Supplier sites may be queried from the underlying database:

- Highlight (make active) the theme of interest (such as Water Supplies)
- Click the Identify button in the ArcView Toolbar
- Click on a Water Supply site icon in the current View with the Identify Tool to obtain details.

Figure 151 illustrates the results of querying one of the Water Supplies.

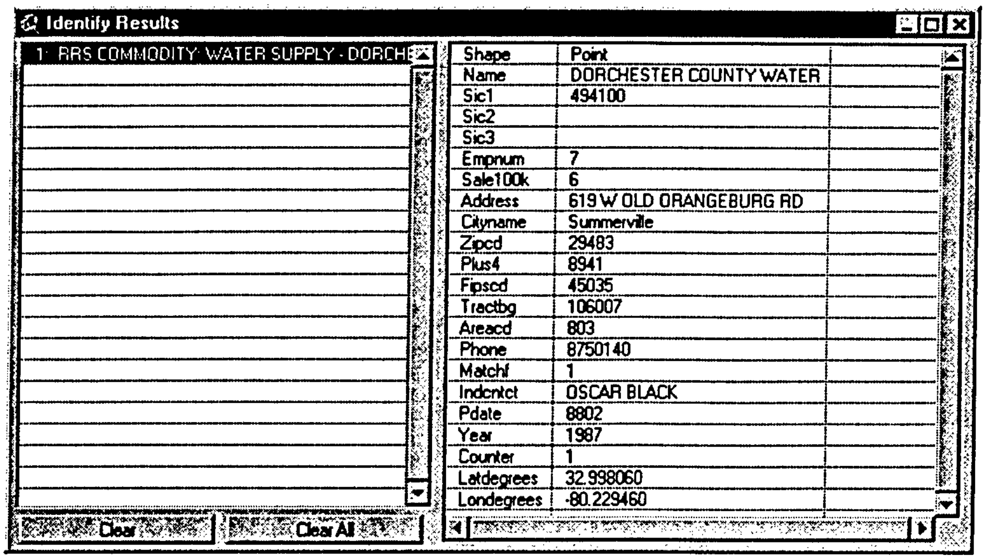


Figure 151. Detailed water supply location data provided by using the ArcView identify tool.

8.3.3 Find Disaster Medical Assistance Team Resource Sites.

After performing Step-1 Initialize Site Query in the second section of the **RRS** command list, the user may choose Find Disaster Medical Assistance Team Resource Sites from the command list to determine locations of sources for specific commodities or other resources. (Note: The initialization procedure needs to be performed only once for all subsequent analyses, unless it is desired to change the initialization criteria) Choose one or more types of commodities/resources from the list provided, as illustrated in Figure 152. Choose a single type by clicking on the desired type with the cursor. Choose multiple types by clicking on the desired types while holding down either the Shift or Cntrl keys. To remove selected types, click on them while holding down the Shift or Cntrl keys.

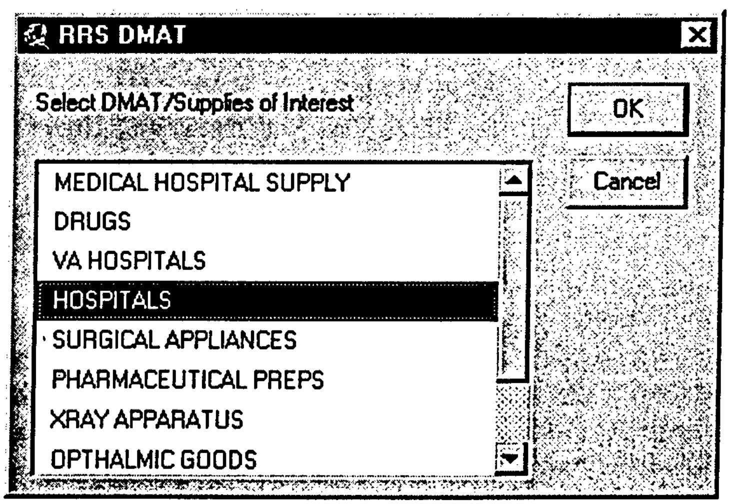


Figure 152. Select medical supply sources for display in the current View.

After selecting the desired medical commodity/resource type or types, those existing within the initialization distance criterion from the desired damage theme are loaded into the current View and displayed as shown in Figure 153, which illustrates the locations of hospitals nearby damage created by a hypothetical Charleston, SC, earthquake.

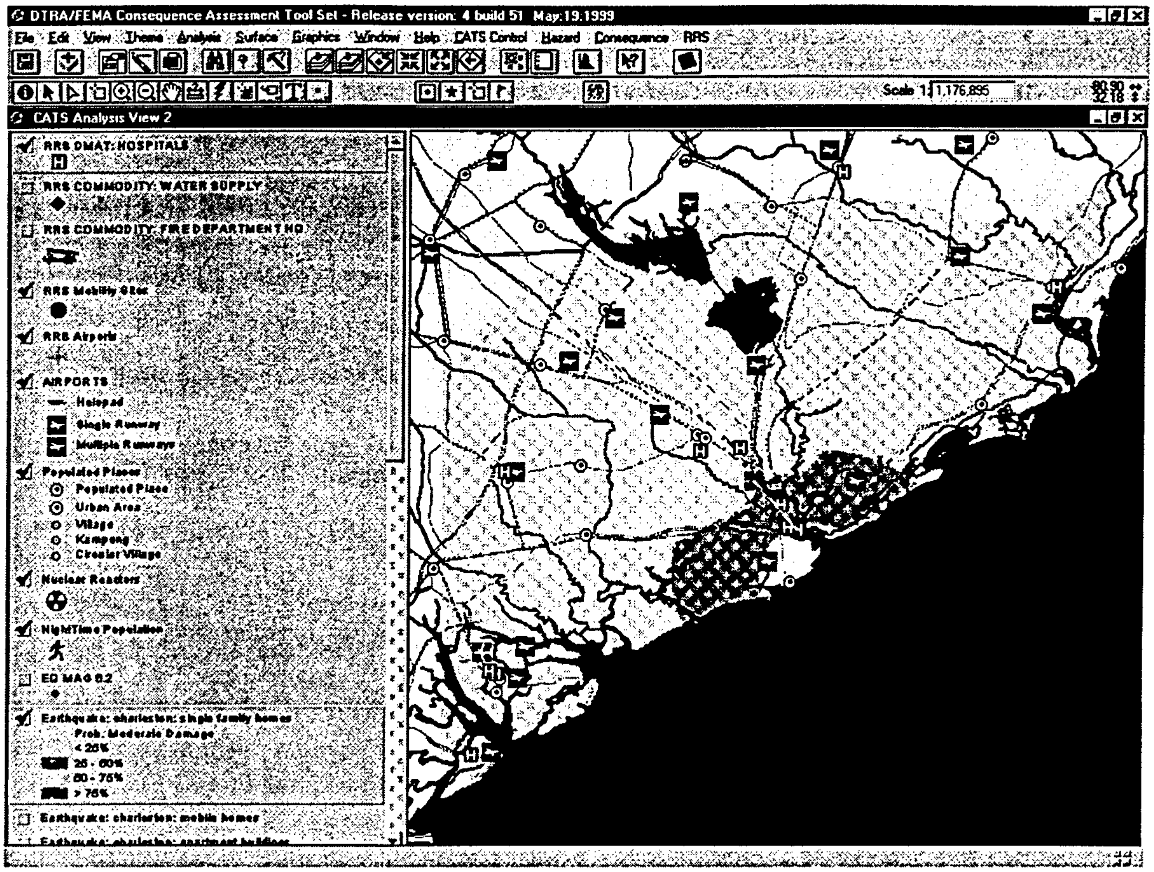


Figure 153. Display of selected medical resources: Hospitals.

More detailed data regarding the Hospital sites may be queried from the underlying database:

- Highlight (make active) the Hospital theme
- Click the Identify button in the ArcView Toolbar
- Click on a Hospital site icon in the current View with the Identify Tool to obtain details.

Figure 154 illustrates the results of querying one of the Hospital theme icons.

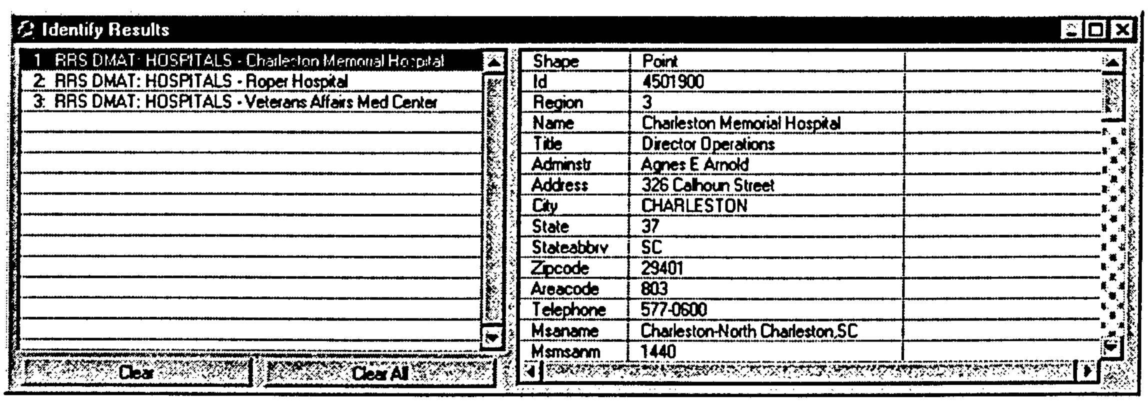


Figure 154. Detailed hospital data provided by using the ArcView identify tool.

8.4 ROADBLOCKS.

In order to perform Roadblocks analysis the user must have installed ESRI Streetmap extension and data base.

WARNING. Use of Roadblocks analysis with hazards larger than approximately 16 square miles is not recommended, as it may overwhelm the system in terms of run time and disk space, depending on regional street density. Use of Roadblocks for large natural hazards, such as hurricanes, is definitely not recommended.

Roadblocks analysis provides graphic and tabular descriptions of street addresses, closure at which is required to interdict a hazard area. After creating a hazard theme,

- Select the Roadblocks command from the RRS menu, as shown previously in Figure 135.
- Select a theme from the list provided.
- Select the desired contour criterion from the list provided; these are identical to those displayed in the hazard legend.

An example of a Roadblocks analysis is shown in Figure 155. Major road locations are marked with a large red cross, other road locations are marked with a small white cross. Activate the Roadblock theme and use the Identify tool to obtain the address of each icon, or go to the Theme Table for the entire list of addresses. Make both the View and the Theme Table visible in the same CATS session. Arrange them as shown in Figure 155, if desired. Highlight a location of interest in the Table, and the corresponding location in the View will be highlighted.

Figure 156 shows the detail of a section of the roadblock map presented in its entirety in Figure 155.

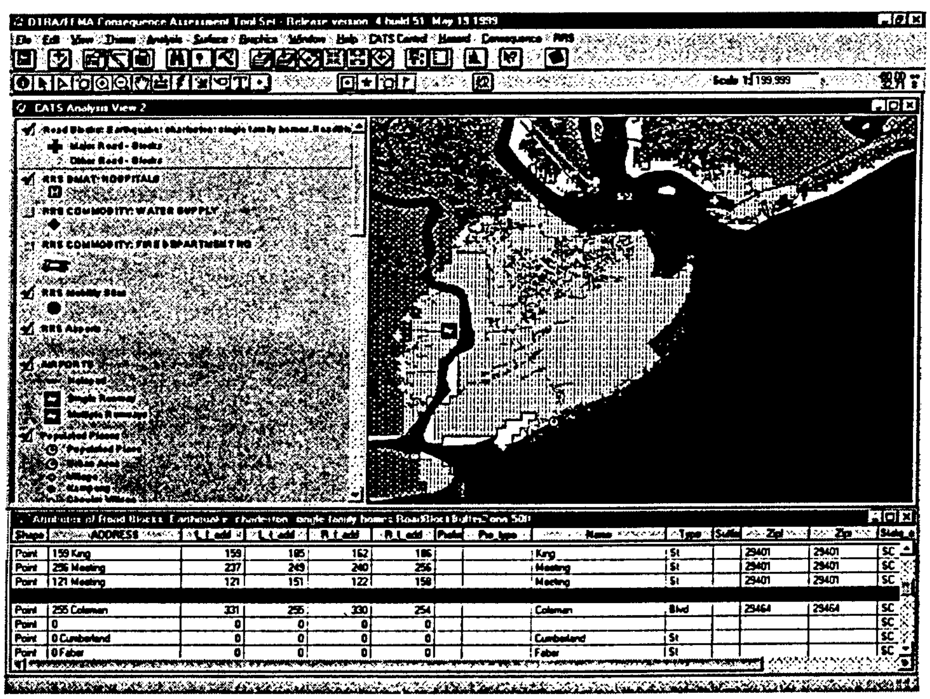


Figure 155. Roadblocks analysis; select address in table to highlight map location.

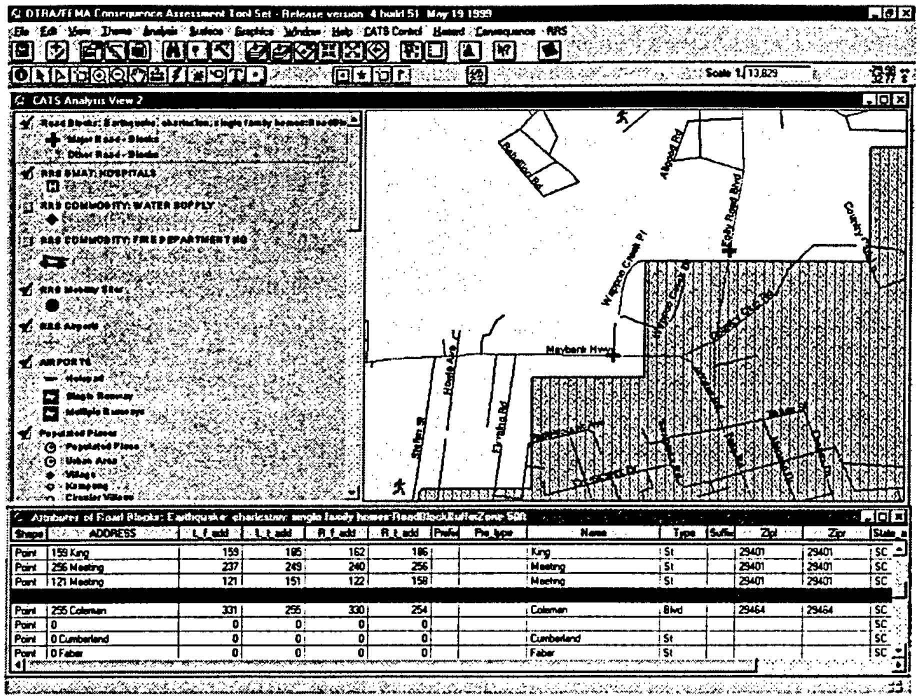


Figure 156. Roadblocks analysis detail; select address in table to highlight map location.

SECTION 9

DATA MANAGEMENT

The value of CATS software lies in the fact that it does more than simply display a graphical representation of a hazard on a map. It allows the user to determine the impact of hazards on spatially distributed assets, in the form of population, government organizations, facilities, purveyors of commodities or event the commodities themselves. It also allows the user to determine the location of assets necessary to support a response to a specified hazard. Data bases describing such assets are provided with CATS. The user is also encouraged to provide additional data bases. This section describes the static data bases provided with CATS and the processes by which these or any databases may be registered for display or analysis in CATS. Static data are so named because, unlike weather and other real-time data, they do not vary significantly with time.

This section also describes the process by which the user may manually create, modify and load data bases into an active view. This description is not intended to provide a substitute for the detailed documentation of the ESRI ArcView software on which CATS is based. Rather it is intended to provide a quick tutorial on those data base functions that are of specific interest to many CATS users.

9.1 CATS STATIC DATABASES.

Table 7 contains a listing of all the databases supplied with CATS. The table contains a brief name, legend file location and name, path to the root of the data directory, source file location and name, origin of the data and, finally, release date.

Table 7. CATS database listing.

NAME	LEGEND	PATH	SOURCE	ORIGIN	DATE
1990 HOUSING BY ZIP CODE		$CATSSTAT/	housing/house90.shp	FEMA MASTER	1992
AIR FLIGHT SERVICE STATIONS		$CATSSTAT/	airport/flightss.shp	FEMA MASTER	1992
AIR NAVIGATIONAL AIDS		$CATSSTAT/	trans/navaids.shp	FEMA MASTER	1992
AIRPORTS	avls/ntsairpt.avl	$CATSSTAT/	airport/ntsairpt.shp	FEMA MASTER	1995
AIRPORTS - AIR FORCE AIRPORTS		$CATSSTAT/	airport/airairfo.shp	FEMA MASTER	1992
AIRPORTS - ARMY AIR AIRPORTS		$CATSSTAT/	airport/airarmy.shp	FEMA MASTER	1992
AIRPORTS - NAVAL AIR BASES		$CATSSTAT/	airport/airnavy.shp	FEMA MASTER	1992
AIRPORTS - PRIVATE AIRPORTS		$CATSSTAT/	airport/airprvte.shp	FEMA MASTER	1992
AIRPORTS - PUBLIC AIRPORTS		$CATSSTAT/	airport/airpubli.shp	FEMA MASTER	1992
AIRPORTS (US & TERRITORIES)		$CATSSTAT/	airport/airports.shp	FEMA MASTER	1992
AIRPORTS (WORLD)	avls/aepoint.avl	$CATSSTAT/	dcwworld/aepoint.shp	DCW (ESRI)	1992
AIRPORTS <= 5000 FT		$CATSSTAT/	airport/airfield.shp	FEMA MASTER	1992
ALL RAIL SITES		$CATSSTAT/	rail/rrcompny.shp	FEMA MASTER	1992
AMTRAK		$CATSSTAT/	rail/rrcoamtk.shp	FEMA MASTER	1992
ATCHISON, TOPEKA AND SANTA FE		$CATSSTAT/	rail/rrcoatsf.shp	FEMA MASTER	1992
ATF		$CATSSTAT/	govern/atf.shp	FEMA MASTER	1992
ATTORNEYS		$CATSSTAT/	personel/attornys.shp	FEMA MASTER	1992

NAME	LEGEND	PATH	SOURCE	ORIGIN	DATE
BALTIMORE AND OHIO		$CATSSTAT/	rail/rrcobo.shp	FEMA MASTER	1992
BORDERS & SHORELINE	avls/ponetln.avl	$CATSSTAT/	dcwconus/borders.shp	DCW (ESRI)	1992
BORDERS & SHORELINE (WORLD)	avls/ponetln.avl	$CATSSTAT/	dcwworld/borders.shp	DCW (ESRI)	1992
BURLINGTON NORTHERN		$CATSSTAT/	rail/rrcobn.shp	FEMA MASTER	1992
CANADIAN PACIFIC		$CATSSTAT/	rail/rrcocpr.shp	FEMA MASTER	1992
CHEMICAL PLANTS		$CATSSTAT/	chemplnts/chemical.shp	FEMA MASTER	1992
CHESAPEAKE AND OHIO		$CATSSTAT/	rail/rrcoco.shp	FEMA MASTER	1992
CHICAGO & NORTHWESTERN		$CATSSTAT/	rail/rrcocnw.shp	FEMA MASTER	1992
COAL MINES		$CATSSTAT/	energy/coal.shp	FEMA MASTER	1992
COAST GUARD		$CATSSTAT/	trans/coastgrd.shp	FEMA MASTER	1992
COKE PLANTS		$CATSSTAT/	energy/coke.shp	FEMA MASTER	1992
COMUNICATIONS NODES		$CATSSTAT/	comms/nodesnet.shp	FEMA MASTER	1992
CONRAIL		$CATSSTAT/	rail/rrcocrr.shp	FEMA MASTER	1992
CONSTRUCTION MATERIALS	avls/cnstmtls.avl	$CATSSTAT/	equifax/cnstmtls.shp	FEMA RRS	1995
COUNTRY NAMES	avls/country.avl	$CATSSTAT/	dcwworld/country.shp	DCW (ESRI)	1992
COUNTY LOCATIONS (centroids)		$CATSSTAT/	counties/cntycent.shp	FEMA MASTER	1992
DEA		$CATSSTAT/	govern/dea.shp	FEMA MASTER	1992
DEEP WATER LOCKS & DAMS		$CATSSTAT/	trans/locksdam.shp	FEMA MASTER	1992
DEPARTMENT STORES	avls/deptstrs.avl	$CATSSTAT/	equifax/deptstrs.shp	FEMA RRS	1995
DEPT OF JUSTICE		$CATSSTAT/	govern/justice.shp	FEMA MASTER	1992
DRUGS	avls/drugs.avl	$CATSSTAT/	equifax/dmat/drugs.shp	FEMA RRS DMAT	1995
EBS AM-FM-TV EMP		$CATSSTAT/	comms/amfmtvem.shp	FEMA MASTER	1992
ELECTRIC PWR PLANTS		$CATSSTAT/	energy/electric.shp	FEMA MASTER	1992
ELECTRICAL APPLIANCES	avls/electapl.avl	$CATSSTAT/	equifax/electapl.shp	FEMA RRS	1995
ELECTRO MEDICAL EQUIPMENT	avls/elecmed.avl	$CATSSTAT/	equifax/dmat/elecmed.sh p	FEMA RRS DMAT	1995
ELECTRONIC PARTS	avls/electpts.avl	$CATSSTAT/	equifax/electpts.shp	FEMA RRS	1995
ENERGY IMPORT FACILITIES		$CATSSTAT/	energy/petimprt.shp	FEMA MASTER	1992
ESRI STREETMAP		$ESRISMHOME	usa_st.bms	FEMA MASTER	1992
FABRIC MILLS	avls/fabrcmls.avl	$CATSSTAT/	equifax/fabrcmls.shp	FEMA RRS	1995
FBI		$CATSSTAT/	govern/fbi.shp	FEMA MASTER	1992
FEMA PERSONEL		$CATSSTAT/	personel/personel.shp	FEMA MASTER	1992
FEMA REGIONAL CENTERS		$CATSSTAT/	govern/femafrcs.shp	FEMA MASTER	1992
FEMA REGIONS & STATES		$CATSSTAT/	govern/ebsfema.shp	FEMA MASTER	1992
FIRE DEPARTMENT	avls/fire.avl	$CATSSTAT/	equifax/fire.shp	FEMA RRS	1995
FURNITURE STORES	avls/frntrstr.avl	$CATSSTAT/	equifax/frntrstr.shp	FEMA RRS	1995
GRAND TRUNK (ME & NH)		$CATSSTAT/	rail/rrcocn.shp	FEMA MASTER	1992
HAND TOOLS	avls/hndegtl.avl	$CATSSTAT/	equifax/hndegtl.shp	FEMA RRS	1995
HARDWARE	avls/hardware.avl	$CATSSTAT/	equifax/hardware.shp	FEMA RRS	1995
HELICOPTER PADS		$CATSSTAT/	airport/heliport.shp	FEMA MASTER	1992
HOSPITALS	avls/hospital.avl	$CATSSTAT/	hospitals/hospital.shp	FEMA RRS DMAT	1995
HUD FIELD OFFICES		$CATSSTAT/	housing/hudsites.shp	FEMA MASTER	1992
ICE MANUFACTURER	avls/manufice.avl	$CATSSTAT/	equifax/manufice.shp	FEMA RRS	1995

NAME	LEGEND	PATH	SOURCE	ORIGIN	DATE
ILLINOIS CENTRAL GULF		$CATSSTAT/	rail/rrcoicg.shp	FEMA MASTER	1992
IMMIGRATION		$CATSSTAT/	govern/ins.shp	FEMA MASTER	1992
INDUSTRIAL MACHINERY	avls/indmach.avl	$CATSSTAT/	equifax/indmach.shp	FEMA RRS	1995
INLAND WATERWAYS LOCKS & DAMS		$CATSSTAT/	trans/locksriv.shp	FEMA MASTER	1992
INTERSTATE STRUCTURES		$CATSSTAT/	trans/ihnation.shp	FEMA MASTER	1992
IRRIGATION DAMS		$CATSSTAT/	dams/damirig.shp	FEMA MASTER	1992
LAKES	avls/dnnetpy.avl	$CATSSTAT/	dcwconus/lakes.shp	DCW (ESRI)	1992
LAND MASSES & OCEAN	avls/ponetpy.avl	$CATSSTAT/	dcwconus/ponet.shp	DCW (ESRI)	1992
LAND MASSES & OCEAN (WORLD)	avls/ponetpy.avl	$CATSSTAT/	dcwworld/ponet.shp	DCW (ESRI)	1992
LAWLEGAL		$CATSSTAT/	govern/lawlegal.shp	FEMA MASTER	1992
LIVESTOCK INVENTORY		$CATSSTAT/	livestock/livestok.shp	FEMA MASTER	1992
LOCAL EOCS		$CATSSTAT/	govern/localeoc.shp	FEMA MASTER	1992
LONG ISLAND		$CATSSTAT/	rail/rrcoli.shp	FEMA MASTER	1992
LOUISVILLE-NASHVILLE		$CATSSTAT/	rail/rrcoln.shp	FEMA MASTER	1992
LUMBER BUILDING MATERIALS	avls/lbrbldmt.avl	$CATSSTAT/	equifax/lbrbldmt.shp	FEMA RRS	1995
LUMBER PLYWOOD	avls/lbrplywd.avl	$CATSSTAT/	equifax/lbrplywd.shp	FEMA RRS	1995
MAJOR POSTAL SITES		$CATSSTAT/	postal/uspsmpf.shp	FEMA MASTER	1992
MEDICAL HOSPITAL SUPPLY	avls/medhosp.avl	$CATSSTAT/	equifax/dmat/medhosp.s hp	FEMA RRS DMAT	1995
MEDICAL PERSONNEL		$CATSSTAT/	personel/medstaff.shp	FEMA MASTER	1992
MILWAUKEE		$CATSSTAT/	rail/rrcomilw.shp	FEMA MASTER	1992
MISCELLANEOUS COMPANIES		$CATSSTAT/	rail/rrcomisc.shp	FEMA MASTER	1992
MISSOURI PACIFIC		$CATSSTAT/	rail/rrcomp.shp	FEMA MASTER	1992
MOTORS GENERATORS	avls/motrsgen.avl	$CATSSTAT/	equifax/motrsgen.shp	FEMA RRS	1995
NATURAL GAS PLANTS		$CATSSTAT/	energy/ngpp.shp	FEMA MASTER	1992
NATURAL GAS STORAGE		$CATSSTAT/	energy/ngus.shp	FEMA MASTER	1992
NETWORK		$CATSSTAT/	comms/network.shp	FEMA MASTER	1992
NIGHT TIME POPULATION	avls/demog.avl	$CATSSTAT/	usa/population/point/bg9 0pt.shp	1990 Census Data (Block Group)	1992
NORFOLK & WESTERN		$CATSSTAT/	rail/rrconw.shp	FEMA MASTER	1992
NUCLEAR POWER PLANTS		$CATSSTAT/	reactors/nuclear.shp	FEMA MASTER	1992
NUCLEAR REACTORS	avls/reactors.avl	$CATSSTAT/	reactors/reactors.shp	HPAC Reactor Data File	1994
OIL REFINERIES		$CATSSTAT/	energy/refinery.shp	FEMA MASTER	1992
OPTHALMIC GOODS	avls/opthgds.avl	$CATSSTAT/	equifax/dmat/opthgds.sh p	FEMA RRS DMAT	1995
PBS AM-FM,TV ALL		$CATSSTAT/	comms/ebsbroad.shp	FEMA MASTER	1992
PHARMACEUTICAL PREPS	avls/phrmprep.avl	$CATSSTAT/	equifax/dmat/phrmprep. shp	FEMA RRS DMAT	1995
PITTSBURGH-LAKE ERIE		$CATSSTAT/	rail/rrcople.shp	FEMA MASTER	1992
PLASTIC BOTTLES	avls/plstcbot.avl	$CATSSTAT/	equifax/plstcbot.shp	FEMA RRS	1995
POLICE DEPARTMENTS	avls/police.avl	$CATSSTAT/	equifax/police.shp	FEMA RRS	1995
POPULATED PLACES	avls/pppoint.avl	$CATSSTAT/	dcwconus/pppoint.shp	DCW (ESRI)	1992
PORTS - EAST COAST		$CATSSTAT/	trans/porteast.shp	FEMA MASTER	1992

NAME	LEGEND	PATH	SOURCE	ORIGIN	DATE
PORTS - INLAND WATERWAYS & TERMI		$CATSSTAT/	trans/portsriv.shp	FEMA MASTER	1992
PORTS - WEST COAST		$CATSSTAT/	trans/portwest.shp	FEMA MASTER	1992
POPULATION (USA, GRID)		$CATSSTAT/	usa/population/grid/ornl	LANDSCAN	1998
POPULATION (EUROPE, GRID)		$CATSSTAT/	world/population/grid/europe	LANDSCAN	1998
POPULATION (MIDEAST, GRID)		$CATSSTAT/	world/population/grid/mideast	LANDSCAN	1998
POPULATION (SCASIA, GRID)		$CATSSTAT/	world/population/grid/scasia	LANDSCAN	1998
POPULATION (USA, TRACT POLYGONS)		$CATSSTAT/	Usa/population/polygon/tracts.shp	1990 Census Data (Tract)	1997
POPULATION (USA, BLOCK GROUP POLYGONS by STATE)		$POLYHOME/	polydata/[two letter state acronym].shp	1990 Census Data (Block Group) for 49 States	1990
PRIMARY FACTORIES		$CATSSTAT/	factory/primarym.shp	FEMA MASTER	1992
PRISONS		$CATSSTAT/	prisons/prisons.shp	FEMA MASTER	1992
PWS		$CATSSTAT/	sewplnts/pws_plan.shp	FEMA MASTER	1992
PWS		$CATSSTAT/	sewplnts/pws.shp	FEMA MASTER	1992
RADIO TELEPHONE EQUIPMENT	avls/radteleq.avl	$CATSSTAT/	equifax/radteleq.shp	FEMA RRS	1995
RADIO TV COMMUNICATIONS	avls/radtvcom.avl	$CATSSTAT/	equifax/radtvcom.shp	FEMA RRS	1995
RAILROAD BRIDGES		$CATSSTAT/	rail/rrbridge.shp	FEMA MASTER	1992
RAILROAD COMPUTERS		$CATSSTAT/	rail/rrcmputr.shp	FEMA MASTER	1992
RAILROAD CONTROLS		$CATSSTAT/	rail/rrcntrol.shp	FEMA MASTER	1992
RAILROAD INTERFACES		$CATSSTAT/	rail/rrintfac.shp	FEMA MASTER	1992
RAILROAD INTERLOCKINGS		$CATSSTAT/	rail/rrintloc.shp	FEMA MASTER	1992
RAILROAD MISCELLANEOUS SITES		$CATSSTAT/	rail/rrmiscel.shp	FEMA MASTER	1992
RAILROAD REPAIR SHOPS		$CATSSTAT/	rail/rrshops.shp	FEMA MASTER	1992
RAILROAD TUNNELS		$CATSSTAT/	rail/rrtunnel.shp	FEMA MASTER	1992
RAILROAD YARDS		$CATSSTAT/	rail/rryards.shp	FEMA MASTER	1992
RAILROADS	avls/rrline.avl	$CATSSTAT/	dcwconus/rail.shp	DCW (ESRI)	1992
RAILROADS (WORLD)	avls/rrline.avl	$CATSSTAT/	dcwworld/rrline.shp	DCW (ESRI)	1992
REACTORS		$CATSSTAT/	reactors/reactors.shp	FEMA MASTER	1992
RICHMOND-FREDRICKSBURG-POTOMAC		$CATSSTAT/	rail/rrcorfp.shp	FEMA MASTER	1992
RIVERS	avls/dnnetln.avl	$CATSSTAT/	dcwconus/rivers.shp	DCW (ESRI)	1992
RIVERS (WORLD)	avls/rivers.avl	$CATSSTAT/	dcwworld/rivers.shp	DCW (ESRI)	1992
ROADS	avls/rdline.avl	$CATSSTAT/	dcwconus/roads.shp	DCW (ESRI)	1992
ROADS (WORLD)	avls/rdline.avl	$CATSSTAT/	dcwworld/roads.shp	DCW (ESRI)	1992
ROCK ISLAND		$CATSSTAT/	rail/rrcori.shp	FEMA MASTER	1992
RRS AIRPORTS	avls/airport.avl	$CATSSTAT/	airport/ntsairpt.shp	NTAB	1995
RRS MOBILITY SITES	avls/mobsite.avl	$CATSSTAT/	govern/gsaallst.shp	FEMA MASTER	1992
RRS RUNWAYS		$CATSSTAT/	airport/runways.shp	FEMA MASTER	1992
SANITARY PAPER PRODUCTS	avls/sanpapr.avl	$CATSSTAT/	equifax/sanpapr.shp	FEMA RRS	1995
SEABOARD COAST LINE		$CATSSTAT/	rail/rrcoscl.shp	FEMA MASTER	1992
SEWAGE TREATMENT PLANTS		$CATSSTAT/	sewplnts/stp.shp	FEMA MASTER	1992
SHADED RELIEF		$CATSSTAT/	cbi/usmaps/clrusmap.dbf	Chaulk Butte Inc.	

NAME	LEGEND	PATH	SOURCE	ORIGIN	DATE
SHADED RELIEF (WORLD)		$CATSSTAT/	cbi/worldm.tif	Chaulk Butte, Inc.	
SOAP DETERGENTS	avls/soapdtrg.avl	$CATSSTAT/	equifax/soapdtrg.shp	FEMA RRS	1995
SOFTDRINKS	avls/sftdrnks.avl	$CATSSTAT/	equifax/sftdrnks.shp	FEMA RRS	1995
SOUTHERN PACIFIC		$CATSSTAT/	rail/rrcosp.shp	FEMA MASTER	1992
SOUTHERN RAILWAY COMPANY		$CATSSTAT/	rail/rrcosou.shp	FEMA MASTER	1992
SPORTING GOODS	avls/sprtggds.avl	$CATSSTAT/	equifax/sprtggds.shp	FEMA RRS	1995
STATE EOCS (PRI & ALT)		$CATSSTAT/	govern/stateeoc.shp	FEMA MASTER	1992
STOCKPIL		$CATSSTAT/	chemws/stockpil.shp	FEMA MASTER	1992
STRATEGIC RESERVE		$CATSSTAT/	energy/spro.shp	FEMA MASTER	1992
SUPERFUND SITES		$CATSSTAT/	superfund/superfun.shp	FEMA MASTER	1992
SURGICAL APPLIANCES	avls/surgappl.avl	$CATSSTAT/	equifax/dmat/surgappl.s hp	FEMA RRS DMAT	1995
SURGICAL MEDICAL	avls/surgmed.avl	$CATSSTAT/	equifax/dmat/surgmed.s hp	FEMA RRS DMAT	1995
TANK FARMS		$CATSSTAT/	energy/tankfarm.shp	FEMA MASTER	1992
UNION PACIFIC		$CATSSTAT/	rail/rrcoup.shp	FEMA MASTER	1992
Urban Areas	avls/pppoly.avl	$CATSSTAT/	dcwconus/urban.shp	DCW (ESRI)	1992
Urban Areas	avls/pppoly.avl	$CATSSTAT/	dcwworld/urban.shp	DCW (ESRI)	1992
US CUSTOMS		$CATSSTAT/	govern/uscustms.shp	FEMA MASTER	1992
US MARSHALS		$CATSSTAT/	govern/usmarshl.shp	FEMA MASTER	1992
US POSTAL VEHICLE MAINTENANCE		$CATSSTAT/	postal/uspsvmf.shp	FEMA MASTER	1992
US SECRET SERVICE		$CATSSTAT/	govern/usecrets.shp	FEMA MASTER	1992
VA CEMETARY SITES		$CATSSTAT/	cemetary/vacemety.shp	FEMA MASTER	1992
VA HOSPITAL STAFF		$CATSSTAT/	hospitals/vastaff.shp	FEMA MASTER	1992
VA HOSPITALS	avls/vahosptl.avl	$CATSSTAT/	hospitals/vahosptl.shp	FEMA RRS DMAT	1995
WATER SUPPLY	avls/wtrsuply.avl	$CATSSTAT/	equifax/wtrsuply.shp	FEMA RRS	1995
WATER SUPPLY DAMS		$CATSSTAT/	dams/waterdam.shp	FEMA MASTER	1992
WEATHER STATIONS		$CATSSTAT/	wxstat/weather.shp	FEMA MASTER	1992
WHOLESALE GROCERY	avls/wsggroc.avl	$CATSSTAT/	equifax/wsggroc.shp	FEMA RRS	1995
XRAY APPARATUS	avls/xrayapp.avl	$CATSSTAT/	equifax/dmat/xrayapp.sh p	FEMA RRS DMAT	1995

The databases listed in Table 5 are located primarily in the directory set in CATS PREFERENCES as the location of CATS DATA, illustrated in Figure 157. This is set as the CATS global variable $CATSSTAT. The default for $CATSSTAT is CATS_STAT, under the CATS home directory. Census data by state, in which the population is distributed over block group polygons, is a very large database, approximately 563 MB. Its location may be set in CATS PREFERENCES independently of that for all other data. The final data base whose location is specified in SET PREFERENCES is ESRI Street Map. These data correspond to the HIGHWAY and STREETS directories from the ESRI Street Map data CDROM. They may be placed on any accessible drive but are most often install in the ESRIDATA subdirectory, located under the ESRI root directory.

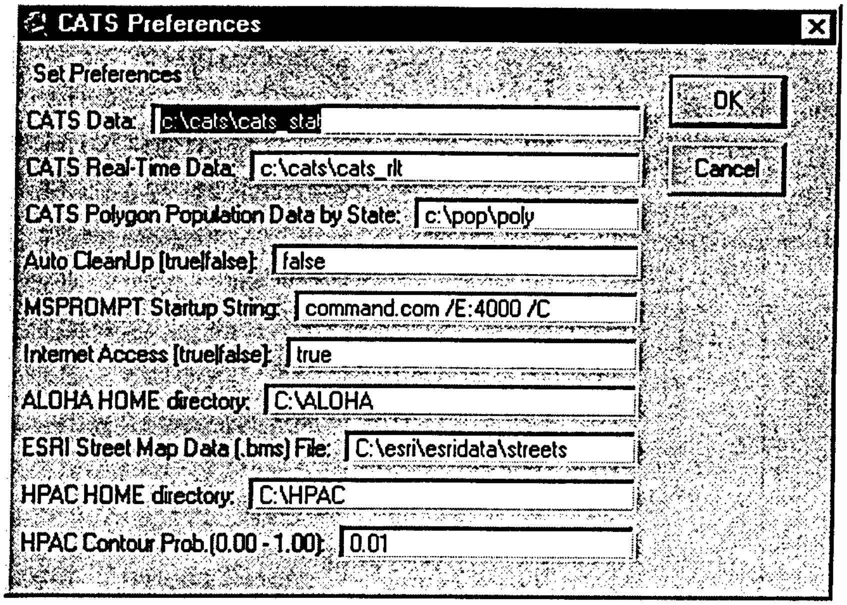


Figure 157. CATS Preferences input screen.

Each of the data bases listed in Table 7, having a shape (*.shp) file as its SOURCE, consists of a multiple file set. Each file has the same name, with several different extensions, which include *.dbf . The *.dbf file contains data in tabular form, which consists of multiple records (rows), each having many fields (columns). Each record corresponds to a specific location, hence two of the fields are always latitude and longitude. In the case of line or polygon data, such as roads, rivers, etc., the locations represent end points of line segments. In the case of point data, such as those for hospitals, airfields, etc., the location is marked by a single icon and the supporting data includes a detailed description of the facility. Because of the need to keep the *.dbf file as compact as possible, quantities included in the description are often either in code or abbreviated to the point of being gibberish. Therefore, translations for the quantities listed in many of the CATS data bases are provided in Appendix C of this manual.

9.2 CREATE SCENARIO DEFAULTS.

The CREATE CATS SCENARIO command under the CATS Menu (Project Screen) and CATS Control (View Screen) menus permits the user to create a new view, loaded with a pre-selected inventory of base data. The base data available for use in creating a new view are listed in data files. These files are referred to as "DEF" files, because they are named according to the convention *def.dbf. Each record in these files contains a source of static data that may be used to construct the background for a new scenario. Each field contains information relating to the location of the file or the manner in which it is loaded into the active view or used in CATS analysis. The fields of the "DEF" files are described in Table 8.

Table 8. Fields comprising a DEF file record.

Name	Theme name used in the table of contents
Legend	Name and location of a legend format (*.avl) file relative to the location of the static data directory (designated in Path field)
Path	Directory containing the data files; $CATSSTAT is the name of the global variable set equal to the location of CATS Static Data files in CATS System Settings; $ESRISMHOME is the name of the global variable set equal to the location of ESRI Street Map data in CATS System Settings
Source	Name and location of a data file relative to the location of the static data directory (designated in Path field)
Minscale	Minimum scale at which data are displayed

Name	Theme name used in the table of contents
Maxscale	Maximum scale at which data are displayed
Metadata	Data Origin
Isftheme	Designates data as ArcView Feature Theme type (true for *.shp files, otherwise false)
Layerorder	Order in which data are loaded into table of contents, from bottom up; table of contents order and order of objects displayed in view are the same
Display	Load data with theme display box checked
Imglibrary	Designates data as ArcView Image Theme type (true for georeferenced *.tif and other georeferenced image files)
Loadasdefa	Designates data to be loaded into view; true = load; false = no load
Arclibrary	Designates data as ArcView Library Theme type
Layeractiv	Load data with theme active; upon completion of loading, view zooms to extent of all active themes
Alternaten	Alternate name for data
RRS layer	Infrastructure data available for use in RRS analysis, true or false
Themesize	Data file size in MB
Category	Not Used
Facname	Not Used

Two DEF files are provided with the CATS install package, CONUSDEF.DBF for the contiguous continental United States and WORLDDEF.DBF for the entire world. The user may modify these files, using procedures described in Section 9.5, below, or add additional DEF files. New files must be named according to the convention *def.dbf in order to be recognized for listing in the Create Scenario file service screen. DEF files must be located in the root directory named in System Settings as the location of CATS static data.

9.3 DATA REGISTRATION FOR RRS ANALYSIS.

Response Resource Sustainability (RRS) analysis requires data that are listed in the DEF files described in Section 9.2. Typically, these data pertain either to purveyors of commodities and services useful to general disaster relief efforts or to those of specific interest to disaster medical assistance.

The DEF file data record to be included in RRS analysis, must be registered according to the following requirements and instructions:

- Isftheme field must be TRUE; i.e., the data must be in the form of shape files (a set of files of the same name having extensions *.shp, *.shx, *.dbf and, sometimes, *.sbn).

- Set RRS layer field to TRUE

- Set METADATA field to EQUIFAX for the data to be entered in the Commodities Resource Sites list or to EQUIFAXDMAT for the data to be entered in the Disaster Medical Assistance Team Resource Sites list.

9.4 DATA REGISTRATION FOR CONSEQUENCE ASSESSMENT.

Demography (population) and infrastructure (installations and objects) data are used to perform consequence assessment in CATS. Demography and infrastructure data bases are registered consequence assessment use in the data base files DEMOG.DBF and INFRA.DBF, respectively.

9.4.1 Demography Data Population Effects and At-Risk Analysis

CATS makes use of a variety of population data bases in its effects and at-risk analysis. These data bases derive from many different sources, providing differing degrees of precision and amounts of information detail.

Demography data bases are registered for use in the DEMOG.DBF file, which is located in the CATS root directory. The fields making up a DEMOG file record are provided in Table 9. The user may modify the DEMOG file, using procedures described in Section 9.5, below.

Table 9. Fields comprising a record of the DEMOG file.

Name	**Name used in the list of available demography data options**
Path	Directory containing the data files; $CATSSTAT is the name of the global variable set equal to the location of CATS Static Data files in CATS System Settings; $POLYHOME is the name of the global variable set equal to the location of CATS Polygon Population by State Data files in CATS System Settings
Source	Name and location of a data file relative to the location designated in Path field
Datatype	Polygon, Point or Grid
Pop100fld	Data base field containing total population data
Hu100fld	Data base field containing total housing unit data
Nh_use	Data available for use in Natural Hazard Consequence Assessment; for entry to be TRUE, data base must include population breakout by housing type (currently limited to 1990 Census Point Population Data)
Mhpop	Data base field name containing mobile home population breakout
Sfpop	Data base field name containing single family home population breakout
Mfpop	Data base field name containing multifamily home population breakout
Admin1	Data base field name for additional breakout detail
Admin2	Data base field name for additional breakout detail

9.4.2 Infrastructure Data.

CATS data bases contain detailed descriptions of infrastructure objects and facilities that may be placed at risk by natural or technological hazards. The INFRASTRUCTURE command under the Consequence menu provides a list of object and facility types available for at-risk assessment. The contents of that list are derived from the infrastructure data bases registered for use in the INFRA.DBF file, which is located in the CATS root directory. The fields making up a INFRA file record are provided in Table 10. The user may modify the DEMOG file, using procedures described in Section 9.5, below.

Table 10. Fields comprising an INFRA file record.

Name	Name used in the list of available infrastructure data options
Legend	Not used
Path	Directory containing the data files; $CATSSTAT is the name of the global variable set equal to the location of CATS Static Data files in CATS System Settings
Source	Name and location of a data file relative to the location of the static data directory (designated in Path field)
Minscale	Not used
Maxscale	Not used
Metadata	Data Origin
Isftheme	Isftheme = True adds Name to list of data available for Infrastructure at risk assessment; also, designates data as ArcView Feature Theme type (true for *.shp

Name	Name used in the list of available infrastructure data options
	files, otherwise false)
Layerorder	Not used
Display	Not used
Imglibrary	Not used
Loadasdefa	Not used
Arclibrary	Not used
Layeractiv	Not used
Alternaten	Alternate name for data
RRS layer	Not used
Themesize	Not used
Category	Not Used NIPC Category of infrastructure theme from the following list: 1. Banking and Finance 2. Communications 3. Electric Power 4. Emergency Services 5. Gas and Oil 6. Government 7. Transportation 8. Water Supply 9. Miscellaneous
Facname	Name of field containing infrastructure facility/object name

9.5 DATA BASE CREATION AND MODIFICATION.

The data base format most commonly used in CATS is the DBF format and are written with the extension *.dbf. This format is read and written by all relational data base codes, by spreadsheet codes and by the ArcView software on which CATS is based. Creating and modifying DBF files in spreadsheet programs is not recommended. Problems have been encountered having to do with truncation of field data because of conflicts between font and column width. Such truncation is likely to cause CATS operational failure. Instead, it is recommended that data bases be created or modified either in a relational data base code or in CATS itself. The following instructions pertain to creating or modifying a DBF file in CATS.

9.5.1 Creating a Data Base File for Use in CATS.

To create a data base (*.dbf) file for use in CATS, start in the CATS Project Screen and proceed as follows:

- Select the Tables Icon in the table of contents.
- Select NEW and provide an name for the new table in the file service screen; accepting the name enters the user in a blank Table screen.
- From the Edit menu in the Table screen select Add Field, as illustrated in Figure 158.

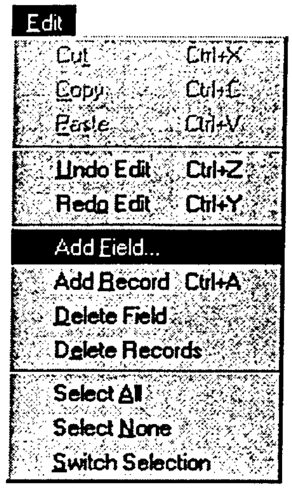


Figure 158. Table edit menu.

- Enter the name of the new field in the Field Definition screen (no spaces allowed), two versions of which are illustrated in Figure 159. It is a good idea to enter the Latitude and Longitude as the first two fields. CATS will look for these fields automatically when the file is loaded as a theme in the active view.

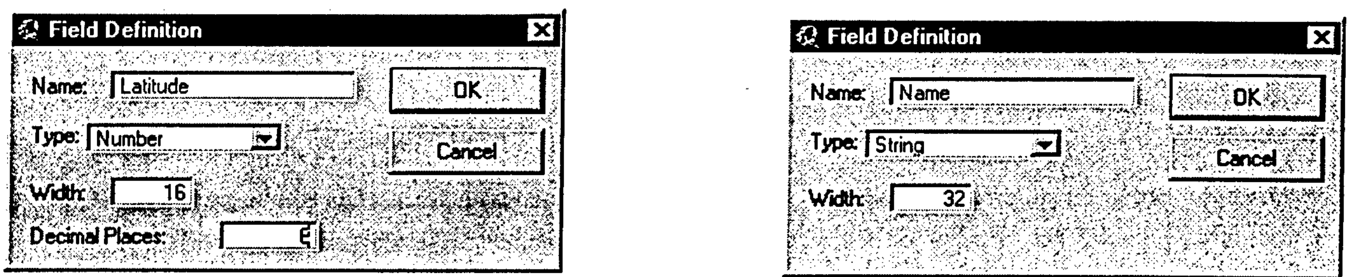


Figure 159. Field Definition data entry screens for Number and String format data.

- Select the Type of field. The most common types are Number for numeric data and String for textual data. The default width (16) is adequate for most number data. Unless it is certain that all entries in the field will be integers, it is best to allow for a large number of decimal places, six usually being sufficient. The default width is likely not to be adequate for most text data. Enter a reasonable estimate for the maximum number of characters likely to be entered in any record in the field.

- Enter all the fields desired.

- Select Add Record from the Edit menu, as illustrated in Figure 158. This will add a record (row) under all the fields entered previously.

- Edit each field for each record.
  - Select the Edit tool from the Table Screen Tool Bar; the cursor become a hand with a pointing finger.
  - Place the cursor on the record/field box to be edited and click the left mouse button. Enter the desired number or text; when finished with one box click on the next until finished. IMPORTANT: After entering data in the last box, exit the edit mode by selecting the Select tool from the Table Screen Tool Bar, otherwise the last edit will be undone when saving the resulting table.

- When finished entering and editing the table, select Stop Editing from the Table menu, as illustrated in Figure 160. The user will be prompted to save the table. The user may also use the Save Edits command to save work at an intermediate point if desired.

9.5.2 Modifying a CATS Data Base File.

To modify an existing CATS data base the following sequence is recommended:

- Copy the *.dbf file component of the shape file of interest and give the copy another name; this if for the safety of the user, to insure that if the modification is unsuccessful nothing will have been lost but some time; check to make sure the new file is not write protected.

- From the CATS Table screen ADD the new file; adding the file also opens the file; note that the OPEN command applies only to files that have already been added to the CATS session.

- Select START EDITING from the Table menu; this command interchanges with Stop Editing, as shown in Figure 160.

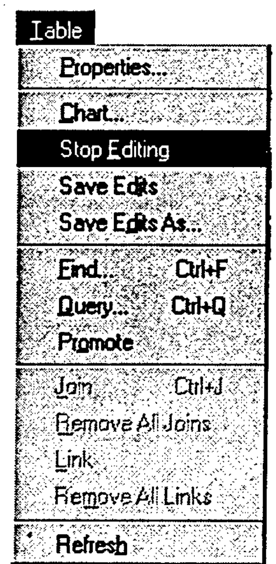


Figure 160. Table menu.

- Proceed with edits, finish and save as described in Section 9.5.1, above; it is recommended that the user add a field, named MODIFIED for example, and enter the date and even an abbreviated description of the modification.

- Return to the active View and manually load the revised data base, according to instructions for adding data bases as themes (load event theme) in Section 9.6, below.

- Make sure that the data base loaded as an event theme is the only active theme (place the cursor in the legend and left click), then select CONVERT TO SHAPEFILE from the View screen Theme menu, as shown in Figure 161.

WARNING: Do not assume that only the *.dbf component of the shape file has changed and that the other components are still valid, while this is possible in the case of small changes it is not guaranteed, thus, when modifying the *.dbf component of a shape file, always remake the shape file.

- Provide a new name for the shape file to be created; upon being queried load the new shape file in the active theme if desired; if the new shape file is loaded, delete the event theme entry from the table of contents.

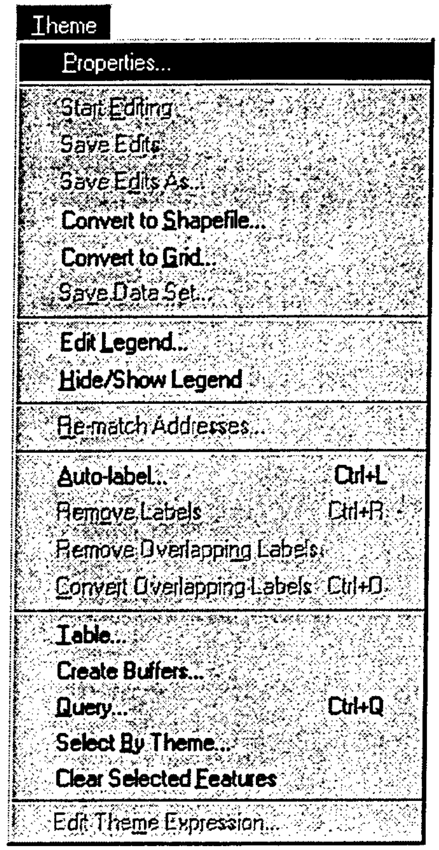


Figure 161. View screen Theme menu.

- Test the properties of the new shape file; if the old shape file was listed in the DEF or other set up files, change the name of the old shape file set or move them to a temporary directory; if necessary copy the new shape file to the directory specified in the set up file and rename it to match that of the shape file it is replacing; exercise the new file using the pertinent CATS function; if the new file behaves satisfactorily, the old file may be archived or deleted.

9.6 ADDING DATA BASES AS THEMES (ADDING EVENT THEMES).

A data base (*.dbf) file may be added to a view without the normal suite of shape file components, as follows:

- Enter the Table screen and ADD the *.dbf file of interest to the CATS session.

- Enter the Viewscreen and select ADD EVENT THEME from the View menu, as illustrated in Figure 162; the Add Event Theme screen allows the user to select from among those tables that have been added to the current CATS session; choose the desired table from the list and, using the list of fields available in the drop down menus, make sure the X field and Y field contain the names of the fields containing Longitude and Latitude, respectively, as shown in Figure 163.

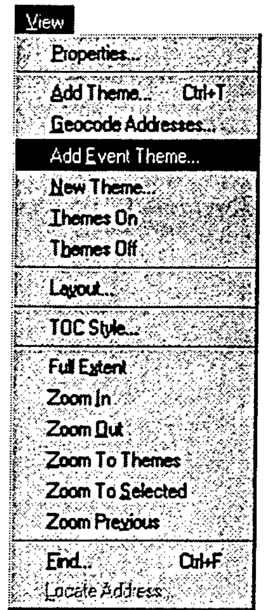


Figure 162. View menu, Add Event Theme.

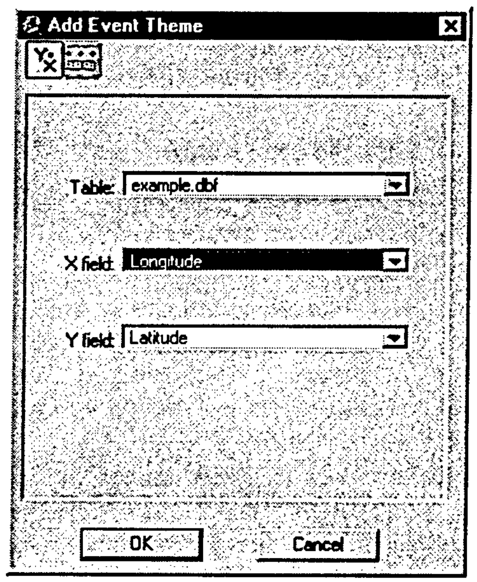


Figure 163. Add Event Theme screen, identify table and x/y fields.

- The event theme is loaded into the active View; turn on the theme, activate the theme and zoom to it if desired; place the cursor on the theme legend and double click with the left mouse button to bring up the Legend Editor; follow ArcView instructions on creating a new legend format if desired.

Note that themes added to the active view in the fashion described above have not been registered for use in CATS analysis and will not be recognized for use in such functions as Consequence Assessment or RRS Analysis unless properly registered, as described above.

Note also that themes added to the active View are retained in that View if the CATS Scenario is saved. However, in order that the theme be reloaded when the Scenario is opened at a later date, the file must

have been retained in the same location as when it was loaded into the active View. If this is not the case, all is not lost; the user is given the chance to browse for the file if CATS cannot locate it.

9.7 ADDING THEMES TO THE ACTIVE VIEW.

Depending on the options loaded in the CATS session theme types that may be added manually to the active View are

- Feature data source (shape files, *.shp)
- Gridded data source (grid files)
- Image data source (*.tif, *.bmp, etc.)
- Street Map data source (*.bms files)

ESRI ArcView documentation offers a complete description of the procedures and limitations associated with the manual loading of these themes.

Feature data sources may be loaded into the active View by selecting ADD THEME from the View menu, as illustrated in Figure 162. Select Feature Data Source as source type and select a shape file from those listed in the file service. The shape file is loaded into the active view with a default legend. Legend definitions (*.avl files) for some of the CATS data base files may be found in the AVL directory under the root of the CATS static data directory. To load the AVL file, position the cursor on the legend, double click with the left mouse button, bringing up the Legend Editor; select LOAD, navigate to the AVL directory and choose an appropriate *.avl file. If no appropriate *.avl file is available, create a custom legend and same it for future use, according to ESRI ArcView instructions.

NOTE: If a hazard theme is loaded manually, the comment field will be blank, and the theme will not be recognized for use in any consequence or RRS analysis. AVL files for most hazard themes are contained in the AVL directory associated with each application in TECH_HAZ under the CATS root directory.

Gridded data sources are comprised of an INFO directory and one or more data directories under a common root. Load gridded data sources by selecting ADD THEME, Gridded Data Source, and navigate to the root directory containing the INFO and data directories. The user will be allowed to choose among the available data directories. Select one and it will be loaded into the active View. Use the Legend Editor to modify the appearance or the data ranges associated with the theme. Note that CATS does not normally display gridded data and contains no *.avl file for use with such themes. Gridded data load as opaque, area coverages, hiding all other screen detail. In order to move the theme to the background, activate the theme click and hold the left mouse button with the cursor on the active theme and drag it downward in the table of contents. This will allow all themes located above the gridded theme to be revealed.

This section deals primarily with the loading of themes from Feature data sources. However, in passing it should be noted that themes from image data sources are not necessarily geo-referenced, i.e., they are not projected on to the globe. A so-called "World" file accompanies those files that are projected. For example a pair of files having the same name and extensions *.tif and *.tfw. Those files that are not geo-referenced may be loaded as pictures, having no spatial connection to the active View.

In the case of the Street Map data source, attempting to load one of the *.bms files supplied with Street Map without having access to the entire suite of supporting directories under a single home directory will result in an error. Therefore, either load the *.bms file from the Street Map CDROM or transfer the content of the CDROM in its entirety to a hard disk directory (HIGHWAYS and STREETS only in the case of USA_ST.BMS), before attempting to manually load a Street Map theme.

SECTION 10

GRAPHICAL REPORT PUBLICATION

CATS creates data base and text documents that contain the results of its analyses, such as Consequence and Response Resource Sustainability (RRS). However, the essence of CATS output is its graphic depiction of events, including the extent of hazards, locations of effected population and infrastructure and locations of commodities and services that may be used in response to an event. Three methods are recommended for creating graphical reports from CATS: Screen capture, View export and Layout export. These are described in the following sections.

10.1 SCREEN CAPTURE.

When a CATS user wishes to quickly capture the image of the current View for use in another application, such as a word processor or presentation graphics software, it is often most convenient to capture a bit map image of the entire CATS screen. If CATS is being operated in full screen mode, this may be done by selecting the **Print Screen** key on the keyboard. This captures an image of the entire screen and sends it to the clipboard. It may then be inserted into another application that is subsequently made active, using that application's ***Paste*** command.

If CATS is not being operated in the full screen mode, the user may still capture the CATS screen alone. First, make sure that the CATS screen is the current active screen. Next, select the **Print Screen** key on the keyboard, while depressing the **Alt** key. The captured image may then be inserted into another application that is subsequently made active, using that application's ***Paste*** command.

Most modern word processor and presentation graphics applications include some capability to edit the pasted image, including cropping the image to include only the portion desired.

10.2 VIEW EXPORT.

In the CATS View screen, the user may select the ***Export*** command under the **File** menu, as shown in Figure 164.

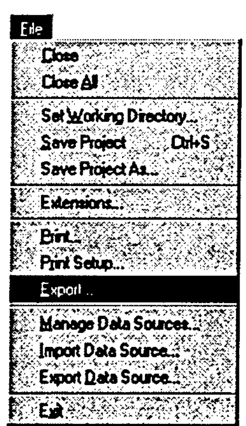


Figure 164. The CATS View window, File menu, Export command.

The user is presented with a file service screen, in which the name, type and location of the exported file may be specified, as illustrated in Figure 165. Several types of graphic files are provided. However, those recommended for use in Windows applications are JPEG, Windows Bitmap and CGM Binary. Of these the JPEG format is usually most economical in terms of file size. The user may further refine the character of file type by selecting the **Options** button and varying the file parameters, as permitted.

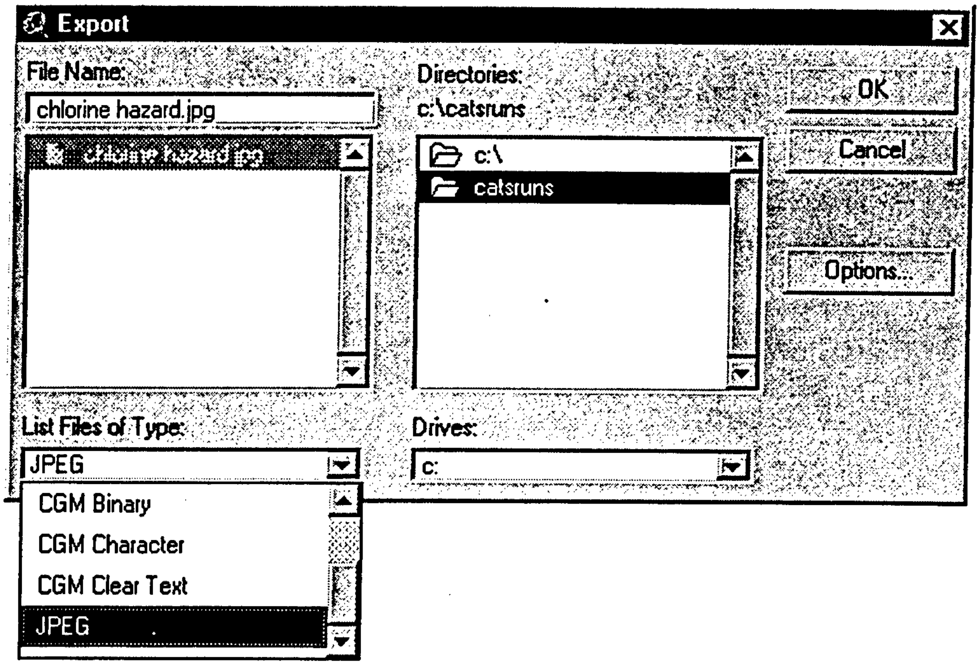


Figure 165. View Export command, file service screen.

An example of an exported CATS View screen is shown below in Figure 166. Note that it does not include the table of contents from the View. The user would have to add this manually, in the form of descriptive text.

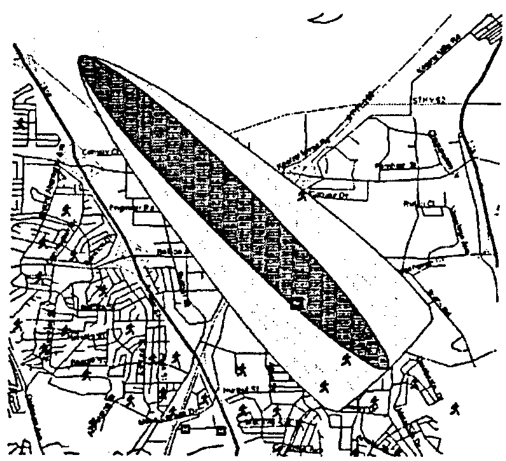


Figure 166. Example of CATS View screen export.

10.3 VIEW LAYOUT.

The user may use the ***Layout*** command under the **View** menu, as shown in Figure 167, to create a more complete depiction of the CATS View screen, including not only the picture from that screen but also desirable elements from the table of contents and other useful pieces of information.

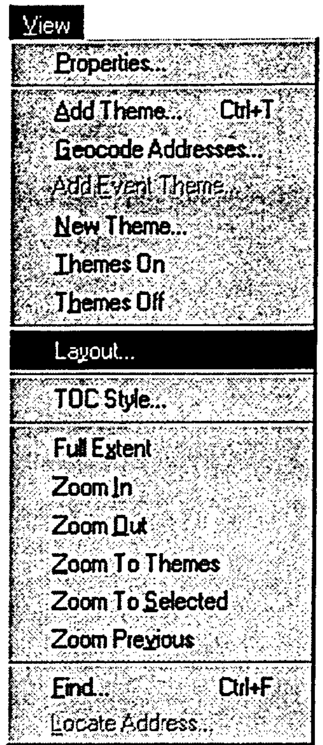


Figure 167. CATS View screen, View menu, Layout command.

10.3.1 Layout Creation.

ArcView provides several default Layout formats as templates. These templates are presented for user selection in a menu box following selection of the ***Layout*** command, as illustrated in Figure 168. Each Layout created from a template automatically includes the following elements:

- Title - Created from that of the active View
- Legend - From the Table of Contents of the active View
- View Frame - The contents of the active View
- Scale device
- Compass device.

The user may choose between landscape and portrait configurations. The user may also choose a format that includes neatlines. A neatline is a border that surrounds some or all elements on a Layout. Finally, the user may choose a template that includes an "inset." An inset is a second View frame in a single Layout. It is most often used to provide a frame of reference for the larger, more detailed main View frame.

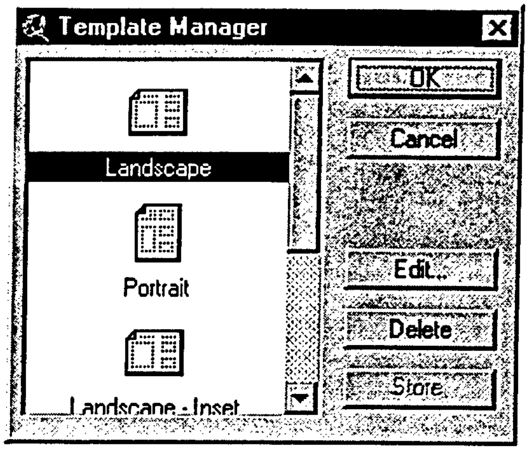


Figure 168. Layout template menu screen.

An example of a Layout created from an active View, using the Landscape – Inset template is shown in Figure 169.

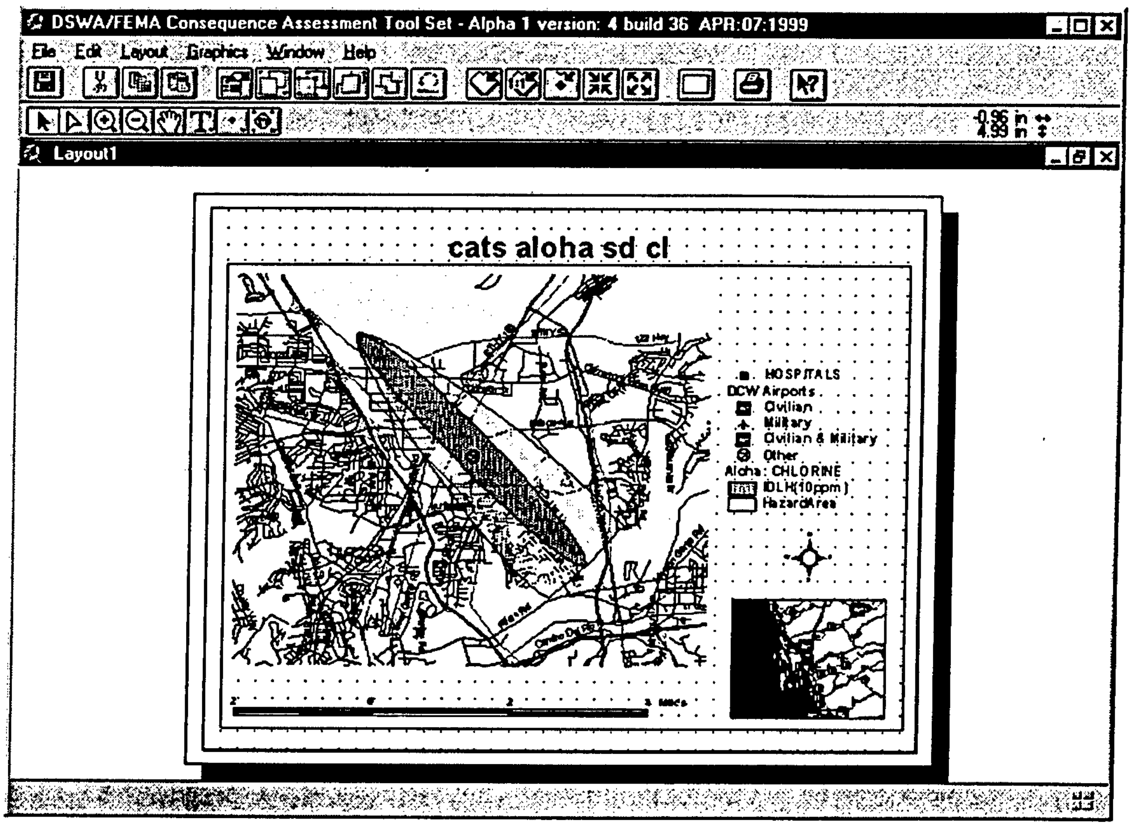


Figure 169. Layout screen showing landscape - inset format.

After creating a Layout from a template, all of the components of the Layout, title, legend, view frame, can be edited.

Title - Double click on the title to take it into an edit box, in which permanent changes may be made, both in content and format. Highlight the title and select the ***Show Symbol Window*** command under the **Window** menu in the Layout screen. Use the control provided to change the font characteristics of the title.

Legend – The legends from the table of contents of all themes that are visible, i.e., turned on, in the active View will be transferred to the Layout legend UNLESS THE LEGEND IS HIDDEN. Therefore, before creating a Layout or after creating a Layout return to the active View and

- Turn off all unnecessary items in the table of contents.
- Use the ***Hide/Show Legend*** command under the **Theme** menu in the View screen to hide the legend of those themes which are to remain visible but whose legends are not desired for inclusion in the Layout. Note that several legends may be hidden at one time. Use the cursor to activate as many legends as desired, while holding down the **Shift** key. Then select the ***Hide/Show Legend*** command to hide the legend.
- After suitably modifying the table of contents of the active View, return to the previously created Layout or create a new one, as desired.
- Highlight the legend and title and select the ***Show Symbol Window*** command under the **Window** menu in the Layout screen. Use the control provided to change the font characteristics of the legend text.

View Frame - Double click on the View frame to gain access to the dialog box that controls its characteristics in the Layout, as illustrated in Figure 170.

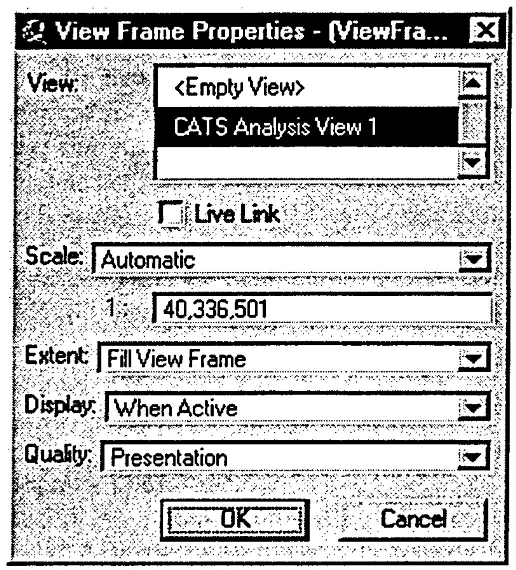


Figure 170. View Frame Properties dialog box.

Dialog box options are as follows:

- View - The name of the View in the frame. Select the View desired from among those available or choose **<Empty View>** and create a View frame that does not contain any data. This frame can be assigned a View at a later time.
- Live Link - The Live Link checkbox determines if the Layout will be "linked" to the View, changing as the View changes, or if it will be a permanent "snapshot" of the current state of the View. If Live Link is checked, the connection between the View and the Layout is preserved. For example, if the symbology in the View is changed, or if a theme is turned on or off, the change is reflected in the Layout. If Live Link is not checked, the connection is cut. This turns the View frame into a 'snapshot' of the current state of the View. Changes made to the View will no longer be reflected in the Layout. Use this option after finalizing a Layout, in order to be able to continue working with the View without changing the Layout.

- Scale –

  Automatic - The scale of the contents of the View frame is determined by the width of the View frame. Change the size of the View frame in the Layout and the contents of the View frame will be scaled to fit inside the resized frame.

  Preserve View Scale - The scale of the View frame is determined by the View's current scale. Use this option to display the contents of the View frame at the same scale as the View, irrespective of the size of the View frame in the Layout. For example, if the selected View is displayed at 1:80,000,000 scale, and Preserve View Scale is chosen, the contents of the View frame will be displayed at that scale even if the View frame is resized.

  User Specified Scale - The scale of the View frame is a user-entered value. Enter the desired scale in the field. Use this option to specify the scale of the contents of the View frame directly. With User Specified Scale, changing the scale at which the View is displayed won't change the scale of contents of the View frame, even if Live Link is on.

- Extent -

  Fill View Frame - The View frame is filled with data from the View. Data not visible in the View will display to fill the View frame. For example, if the contents of the View frame window are smaller than the View frame, ArcView will try to fill the View frame with data from the View. This may result in data appearing in the Layout that is not currently visible in the current extent of your View.

  Clip To View - The contents of the View frame are clipped to be the same as the current extent of the View. Use this option to ensure that only those features currently visible in the chosen View will be displayed in the Layout.

- Display – Refresh frequency

  When Active - The View frame will refresh only when the Layout is active (i.e. it's the uppermost window in ArcView). When the Layout isn't active (i.e. when it's not the uppermost window in ArcView), the contents of the View frame won't redraw until the Layout is made active again.

  Always - The View frame will refresh whenever there is any change to the View.

- Quality - How the data displays in the frame

  Presentation - The View frame will display the View data.

  Draft - The View frame will be a shaded box, serving as a placeholder for where the View data will be drawn.

Refer to the ArcView documentation for more information regarding the creation and editing of Layouts.

10.3.2 Layout Export

In the CATS Layout screen, the user may select the ***Export*** command under the **File** menu, as shown in Figure 171.

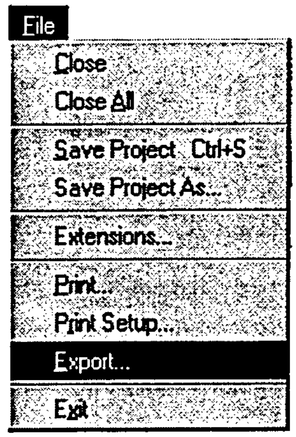


Figure 171. The CATS Layout window, File menu, Export command.

The user is presented with a file service screen, in which the name, type and location of the exported file may be specified, as illustrated in Figure 172. Several types of graphic files are provided. However, those recommended for use in Windows applications are JPEG, Windows Bitmap and CGM Binary. Of these the JPEG format is usually most economical in terms of file size. The user may further refine the character of file type by selecting the **Options** button and varying the file parameters, as permitted.

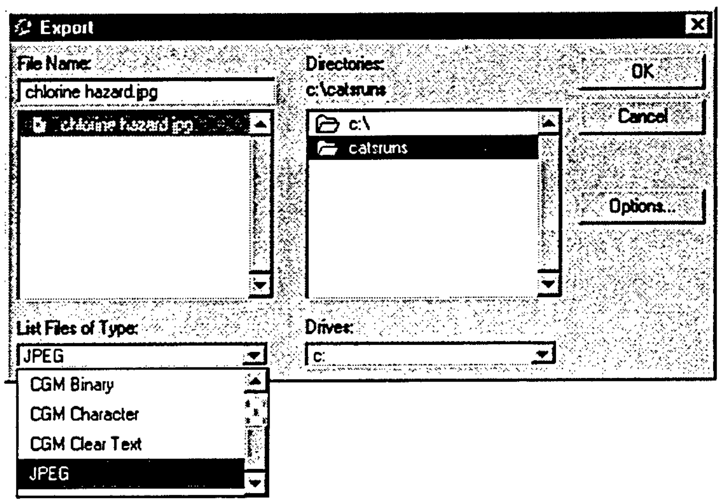


Figure 172. Layout Export command, file service screen.

An example of an exported CATS Layout is shown below in Figure 173.

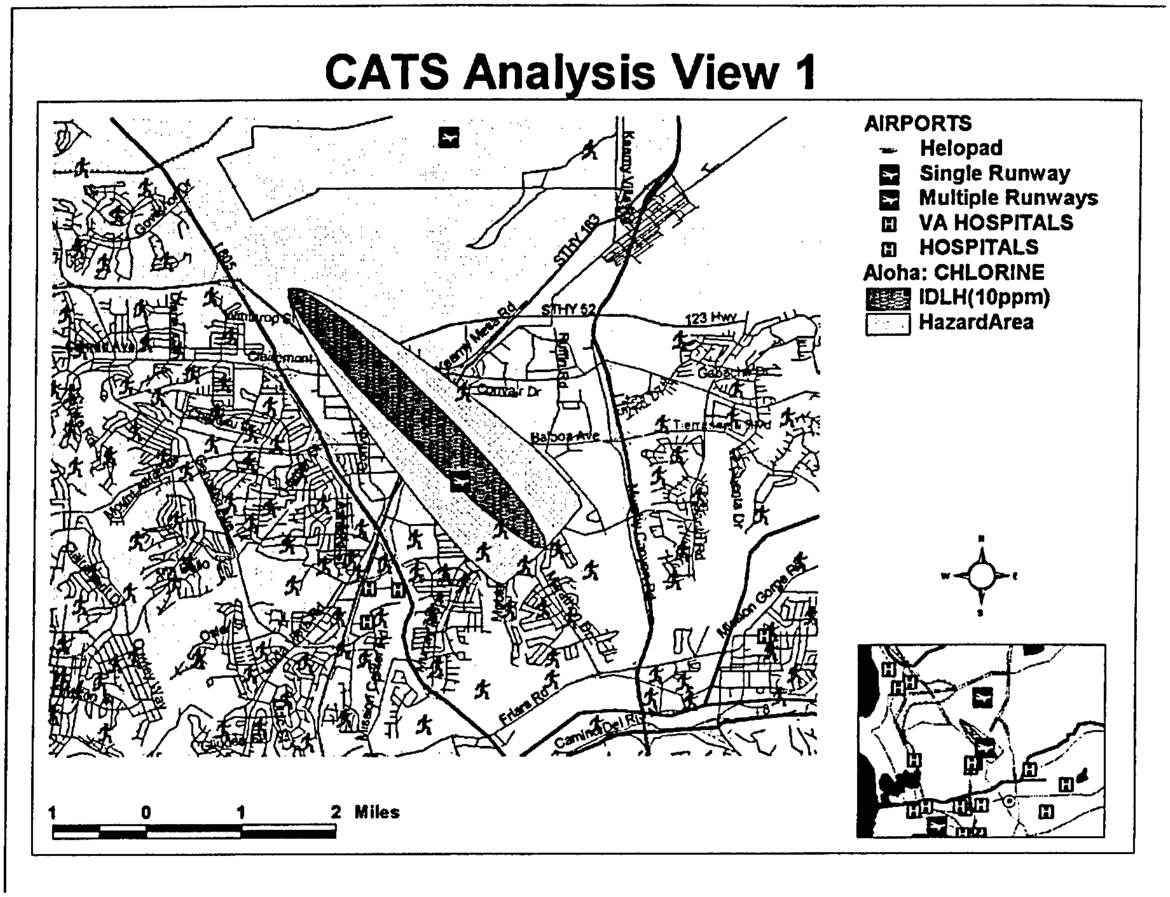


Figure 173. CATS Layout export example.

SECTION 11

LIST OF REFERENCES

1. Environmental Systems Research Institute, Inc., 1993: Digital Chart of the World. ESRI, 380 New York Street, Redlands, CA 92373.

2. Holland, G.J., 1980: An analytical model of the wind and pressure profiles in hurricanes. *Mon. Wea. Rev.*, **108**, 1212-1218.

3. Jarvinen, B. R., and M. B. Lawrence, 1985: An evaluation of the SLOSH storm-surge model. *Bull. Amer. Meteor. Soc.*, 66, 1408-1411.

4. Jelesnianski, C. P., and A. D. Taylor, 1973: A preliminary view of storm surges before and after storm modifications. NOAA Tech. Memo. ERL WMPO-3, Boulder, CO, 33 pp. [Available on request from the National Hurricane Center.]

5. Jelesnianski, C. P., J. Chen, and W. A. Shaffer, 1992: *SLOSH: Sea, Lake, and Overland Surges from Hurricanes.*. NOAA Technical Report NWS 48, DOC/NOAA/NWS, Silver Spring, MD.

6. Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM), 1993: *National Hurricane Operations Plan* (FCM-P12-1993). U.S. Department of Commerce, NOAA, 6010 Executive Boulevard, Suite 900, Rockville, Maryland 20852.

7. Secretariat of the World Meteorological Organization, 1993: Global *Guide to Tropical Cyclone Forecasting* (Report No. TCP-31). WMO Technical Document (WMO/TD)- No. 560.

8. U.S. Army Corps of Engineers, 1992: New Jersey Hurricane Evacuation Study: Technical Data Report 1992.

APPENDIX A

CATS HAZARD MODEL AND DATA DESCRIPTIONS

A.1 HURRICANE WIND DAMAGE ESTIMATION MODULE.

A.1.1 Overview.

The Hurricane Wind Damage Estimation Module was developed to provide emergency managers with an estimate in real-time of civil resources and population at risk from threatening tropical storms. Its primary application is to assist efforts to prepare and recover from such storms by providing sufficient lead time to allow emergency planning, readiness actions, and pre-positioning of appropriate types and amounts of relief supplies and personnel.

The model ingests hurricane observation and forecast data provided by the National Hurricane Center (NHC) in Miami, FL, the Central Pacific Hurricane Center (CPHC) in Honolulu, HI, or the Joint Typhoon Warning Center (JTWC) in Guam in the form of Marine Forecast/Advisory Messages. These messages are disseminated every six hours and can be accessed immediately via the National Weather Service's (NWS) Family of Services (FoS) or the NOAA Weather Wire (NWW), through various university servers on the Internet, or through a commercial vendor of meteorological data. Messages are automatically parsed by the model to extract current and forecast hurricane characteristics, including the current and forecast positions of the storm, its maximum wind speed, and the distribution of wind speeds around the storm. Radial profiles of wind speed and dynamic pressure are analyzed and calculated for each quadrant of the storm at the current and forecast positions. Accepted structural response modeling techniques have been incorporated for determining the susceptibility of a wide selection of infrastructure and residential structure types to the dynamic pressure resulting from hurricane winds.

Areas of light, moderate, and severe damage are estimated for each structure type and are mapped using the ARC/INFO GIS. These "damage bands" are processed to produce ARC/INFO polygon coverages which are intersected in the GIS with numerous databases available from government and commercial sources. The amount of relief support that will be required based on the estimated damage levels and affected population is then determined by the model. Graphical consequence analyses are rapidly constructed by overlaying thematic data layers on the map of areas at risk. Tabular reports are automatically generated that provide estimates of the numbers of meals, tents, cots, blankets, bottles of water, and portable toilets that will be required for effective response and recovery. Subsequently, the sources of the required assistance and the logistics for pre-positioning the proper resources can be identified. Using this automated, integrated system of models, databases, and GIS, the exposure and risk of damage to resources, assets, and population can be anticipated.

The attributes of this model which make it attractive for estimating damage from hurricanes and assessing the consequences include: (1) the adaptation of modeling techniques developed and used operationally by the NWS, (2) the incorporation of highly resolved, accurate databases, (3) use of the ARC/INFO GIS, which has set *defacto* standards adopted by GIS users, and (4) its demonstrated capability to provide rapid, accurate guidance to FEMA for providing a well targeted disaster response to natural disasters since the beginning of the 1993 Atlantic hurricane season.

The components of the Wind Damage Module model are discussed below. Section 1.2 provides a discussion of the sources of model input data and an explanation of their formats. Section 1.3 describes the model used to generate wind and dynamic pressure profiles for estimating damage levels. Section 1.4 provides a discussion of the model used to simulate the decay of maximum wind speeds associated with the hurricane as it moves over land areas. Section 1.5 describes the structural vulnerability models used to establish deterministic and probabilistic estimates of damage.

A.1.2 Model Input Data.

Parsing software was developed and integrated into the model to automatically extract from Marine Forecast/Advisory Messages the input data required to make an estimation of wind damage prior to the landfall of the storm. The following sections provide a discussion of (1) the sources of tropical cyclone information, (2) the criteria for determining the appropriate source of information for a given tropical cyclone, (3) naming systems as they apply to cyclones in different ocean basins, (4) the format and content of the advisories, and (5) the schedule by which they are made available to users.

A.1.2.1 Tropical Cyclone Forecast Centers.

The Wind Damage Module can be applied in any area of the world for which the NWS or the Department of Defense (DoD) provide Marine Advisory Messages. In the Atlantic Ocean basin (north of the equator including the Caribbean Sea and Gulf of Mexico) and in the Eastern Pacific Ocean basin (north of the equator and east of 140oW) the issuance of advisories is the responsibility of the NHC in Miami. In the Central Pacific Ocean basin (north of the equator between 140°W and 180°) issuance of advisories is the responsibility of the CPHC in Honolulu. DoD provides this same service for the Western Pacific and Indian Oceans through the JTWC in Guam.

Since hurricanes are not normally observed in the South Atlantic Ocean that area has not officially been designated to any center. South of the equator and east of 180° warnings are issued by Naval Western Oceanography Center (NAVWESTOCEANCEN), Pearl Harbor, Honolulu, HI.

NHC and CPHC provide information regarding tropical systems users in a number of formats. Tropical Weather Outlooks (TWOs) are prepared and issued four times per day by the NHC for both the Atlantic and Eastern Pacific Basins and by the CPHC for the Central Pacific. They describe significant areas of disturbed weather and their potential for tropical cyclone development out to 48 hours. Tropical Cyclone Discussions are issued four times per day by NHC and CPHC, when appropriate, for the areas described above. These discussions can contain preliminary forecast positions and maximum wind speeds out to 72 hours, along with other technical discussions concerning climatological analyses and forecast or observed changes.

Tropical Cyclone Public Advisories are issued by the NHC for all tropical cyclones in the Atlantic Basin; for the Eastern Pacific, these advisories are issued by the NHC only when a storm is expected to make landfall within 48 hours. These advisories are issued for the Central Pacific by the CPHC for all tropical systems within the area-of-responsibility. All public advisories are issued on the same schedule as the Tropical Cyclone Forecast/Advisories.

It is the Tropical Cyclone Forecast/Advisory, discussed in detail in Section 1.2.4 of this report, which serves as the input data source for the Wind Damage Module. Tropical Cyclone Position Estimates may be issued at times *between* regularly scheduled forecast/advisory messages. These position updates can be issued whenever a storm center is within 200 nautical miles of a U.S. land-based radar and sufficient information is available. No updates to the latest forecast are made available to users as part of the position estimate update. The forecast schedule operates on a strict 6-hour cycle and updates to the latest forecast are made only at the scheduled times unless (a) a significant change occurs, requiring the issuance of a revised forecast package, or (b) conditions require a hurricane or tropical storm watch or warning to be issued.

A.1.2.2 Transfer of Responsibility.

When a tropical cyclone approaches the boundary of an area of responsibility as defined above, a coordinated transfer of warning responsibility takes place. When these transfers of responsibility take place between CPHC and JTWC, this coordination involves the NAVWESTOCEANCEN in Pearl Harbor, HI, as well as the aforementioned forecast centers. When a tropical cyclone crosses 180° from west to east, JTWC will append the statement "Next advisory by CPCH-HNL" to their last advisory.

A.1.2.3 Tropical Cyclone Naming.

Among many other responsibilities they assume, these forecast centers are assigned the task of naming tropical cyclones in their areas of concern. In the Atlantic, Caribbean, and Gulf of Mexico, depression[1] numbers ONE, TWO, THREE are assigned by the NHC after advising the Navy Eastern Oceanography Center (NAVEASTOCEANCEN) in Norfolk, VA. In the Eastern Pacific, depression numbers with the suffix "E", e.g., ONE-E, TWO-E, THREE-E are assigned by the NHC after advising the NAVWESTOCEANCEN. In the Central Pacific, depression numbers with the suffix "C", e.g., ONE-C, TWO-C, THREE-C are assigned by the CPHC after advising the NAVWESTOCEANCEN. In the Western Pacific, depression numbers with the suffix "W", e.g., ONE-W, TWO-W, THREE-W are assigned by the JTWC after advising the NAVWESTOCEANCEN. Assigned identifiers are retained even if the depression passes into another warning area. This is the case for depressions, which originally form in any of the tropical cyclone basins described above.

If a depression intensifies to tropical storm strength[2] it is subsequently named and the associated number is dropped. Names are assigned using the tropical storm naming sequence adopted for a given area of responsibility. A different set of names is used each tropical cyclone season. There are six naming sequences used in the Atlantic and Eastern Pacific tropical cyclone basins. After a sequence is used it is not used again for a period of six years. Names of significant cyclones can be retired and replaced. Both the CPHC and the JTWC use four naming sequences to designate storms that are of tropical storm intensity in their areas of responsibility. These forecast centers use all the names listed in each column before going on to the next column. For the Indian Ocean, JTWC uses a sequential numbering system with the suffixes A and B for Arabian Sea and Bay of Bengal, respectively.

A.1.2.4 Advisory Content.

Marine Advisories are issued by the NHC and CPHC for their areas of responsibility. They contain all the input data required by the Wind Damage Module to estimate damage. They include an indication of the last 6-hourly observation of the location of the center of the cyclone, as indicated by the latitude and longitude to the resolution of tenths of degrees. (The 6-hourly synoptic observation cycle and the 6-hourly Marine Advisory update cycle are out of synchronization by three hours. These three hours represent the time required to perform analyses, generate an updated forecast from data observed on the last 6hourly synoptic cycle, and to disseminate that forecast to users.) Other observed data required by the model and contained in the advisory are the maximum sustained (1-minute average) wind speed (in knots), the central pressure (in millibars), and the distribution of wind speeds around the storm on a per quadrant basis (i.e., northeast, southeast, southwest, northwest). Forecast positions of the storm, as well as an indication of the spatial distribution of wind speeds around the storm center, are provided for 12-, 24-, 36-, 48-, and 72-hour periods.

These advisories are comprised of essentially the same information as the NHC advisories. CATS software has been developed to read and parse each of these message formats for determining input to the damage estimation model.

Tropical cyclones are classified according to their intensity, as measured by the maximum sustained wind speeds associated with the storm at any given time. However, various classification schemes are applied throughout the world and can be based upon sustained wind speeds that are determined using different averaging times. Ultimately, these classifications are less important than the actual wind speeds associated with each system, since it is these sustained winds and short-period gusts which affect damage on structures.

A.1.2.5 Advisory Timing and Identification.

Marine Advisories can be accessed via the NWS FoS/NWW, the Internet, or through a commercial data vendor. The first advisory is normally issued when meteorological data indicate that a tropical depression has formed. Subsequent advisories are issued at 0300, 0900, 1500, and 2100 UTC. Due to the tremendous amount of

[1] A tropical depression is an area of low pressure with organized counterclockwise circulation and winds to 38 mph (33 knots).
[2] A tropical storm is a well organized area of cloudiness showing counterclockwise circulation with winds from 39 to 73 mph (34 to 63 knots).

information and message traffic that is created on communication links between the NWS and users, abbreviated communications headings are assigned to Marine Advisories for identification purposes. These headings consist of three groups of alphanumeric characters with a space between each group. The first group contains a data type indicator (e.g., WT for hurricane), a geographical indicator (e.g., NT for North Atlantic and Caribbean), and a number. The second group contains a location identifier of the message originator (e.g., KMIA for Miami). The third group is a date-time group in UTC (e.g., 240300 would indicate the day of the month (24th day) and the time (0300 UTC)); the number of the month itself is omitted. Communication headers for Marine Advisories issued by NHC (Atlantic and Eastern Pacific), the CPHC (Central Pacific), and the JTWC (Western Pacific) are as follows:

- WTNT21-25 KMIA ddtttt Atlantic Basin (NHC)
- WTPZ21-25 KMIA ddtttt Eastern Pacific Basin (NHC)
- WTPA21-25 PHNL ddtttt Central Pacific Basin (CPHC)
- WHNT01-05 KNGU ddtttt Western Pacific (JTWC)

(Note: The range of numbers (e.g., 21-25) used in these headers refers to the first cyclone in that basin (21), the second cyclone (22), and so on. Headers on messages pertaining to the sixth cyclone again use "21" as the appropriate indicator.)

Marine Advisories continue to be issued until the system in question degenerates below depression intensity. (The last advisory issued for a given tropical cyclone is indicated as such in the narrative section of the message.) Special advisories are issued "off schedule" when certain specific requirements are met. However, a new forecast is not issued until the next scheduled issue time. Regularly scheduled advisories are numbered sequentially starting when a storm is in its earliest stages of development and can trace the history of a given tropical cyclone as it intensifies from a depression, to a tropical storm, to a hurricane or typhoon stage, continuing through weakening stages until it dissipates to less than depression intensity. Special updates issued between the 6-hourly update cycle are indicated by appending a letter designation to the last scheduled message number; the first special update during that six hour period is indicated by appending an "A", the second is indicated by appending a "B", and so on.

A.1.3 Wind Profile Model.

Included in the observed and forecast storm data provided by the advisory messages are the spatial distributions of surface wind speed for each quadrant of the storm. These spatial distributions are provided in terms of the radii, as measured from the storm center, of selected sustained (1-minute average) wind speed thresholds. Radii in each quadrant out to which winds as high as 64, 50, and 34 knots are analyzed to be occurring are provided for the current time (the release time of the message). Beginning with the 1995 tropical cyclone seasons, forecasts of these same radii are provided through and including the 36-hour forecast. Previously, only the forecast radii for wind as high as 50 and 34 knot wind speeds were provided. For lead times of 48 and 72 hours, only the radii of wind speeds as high as 50 and 34 knots are provided, depending on the maximum wind speeds forecast for the storm for the time the forecast is valid.

The observed and forecast distributions of wind speed around the storm center provided by the advisory messages are too sparse to adequately model the spatial variations in damage that can be expected to occur. To rectify the inadequacy of these sparse observed and forecast data, an analytical model of a tropical storm wind profile was modified and adapted to the damage model. This model analyzes the continuous profile of wind speed from the storm center to the range where the wind speed is equal to that of the ambient environment. The spatially continuous wind profile facilitates accurate interpolation *between* observed or forecast data to provide objective estimates of the extent of destructive winds and the continuous spatial variation of these winds within the storm environment.

The model was developed in its original form by G.J. Holland (1980) of the Australian Bureau of Meteorology. It applied two scaling parameters to define the shape of the profile and to determine the location of peak winds relative to the origin. The values of these scaling parameters could be estimated empirically from observations of a given storm or determined climatologically to define a standard hurricane. Tropical storm winds were assumed

to obey the gradient wind balance, except near the area of maximum winds where Holland claimed a cyclostrophic balance is more appropriate. While other models of the radial wind profile in tropical storms have been proposed, Holland demonstrated the superiority of this model when applied to three Australian hurricanes.

This model was modified somewhat before being integrated into the Wind Damage Model. Scaling parameters are iterated by successive approximation to obtain the "best fit" to sparse observed and forecast wind speed radii. Further, the definition of "best fit" is modified so that fitting the radii of higher, more damaging wind speeds is weighted more heavily than lower wind speeds. The ambient atmospheric pressure is also determined through iteration rather than reliance on subjective analysis of real-time data. The observed central pressure of the tropical storm is provided in each advisory; central pressure at forecast times is estimated using the relationship:

$$Pc = 1013 - (Vmax/14)^2$$

where Pc is the central pressure and Vmax is the observed or forecast maximum sustained, 1-minute average wind speed. The ambient atmospheric pressure and the lowest central pressure of the storm are used to model horizontal pressure gradients within the storm environment.

Both a structure as a whole and individual elements of that structure have resonance frequencies that respond to winds of varying periods. For example, windows, shutters, and shingles commonly respond to wind gusts of duration of less than five seconds. Therefore, it is gust velocity over a period of approximately 5 seconds or less that is the quantity most responsible for structural damage and which is required to be converted to dynamic pressure. Ultimately, it is this dynamic pressure that is translated into expected damage levels. It is required that the wind speed averaged over some reference period (in this case that period is one minute) be converted to the probable maximum wind speed averaged over some shorter interval within that period. The usual approach is to define a gust factor, G(t), averaged over several sets of observations, as the ratio of the maximum gust speed of duration "t" seconds to the corresponding 1-minute mean speed:

$$G(t) = 1/n \cdot (Ut / U60)$$

where G(t) is the appropriate gust factor for short period gusts using 1-minute average wind speeds, n is the number of sets of observations used to determine G(t), Ut is the maximum 5 second gust velocity, and U60 is the average 1-minute wind speed. Therefore, G(t) is the mean multiplier on 1-minute average mean sustained wind speeds to produce a maximum gust over a period of "t" seconds.

The gust factor used to convert sustained wind speed to gust velocity in the model is equal to 1.2. This value has been determined through statistical analysis and is the value currently used by the NHC to convert 1-minute averaged wind speed to expected maximum gust velocity.

The radial profiles of maximum expected gust velocities as indicated by the model are subsequently converted to profiles of maximum expected dynamic pressure for each storm quadrant. It is this quantity that is translated into expected damage levels for a given structure type. Structural vulnerability models were developed using copious data resulting from high explosive and nuclear weapon tests at various test sites.

A.1.4 Storm Intensity Decay Model.

An empirical model for predicting the decay of hurricane winds after landfall developed by hurricane researchers at NOAA's Atlantic Oceanographic and Meteorological Laboratory (NOAA/AOML) has been integrated into CATS Version 2.0. In previous versions of CATS, the rate of change of storm intensity between times indicated in the hurricane advisories had been assumed to occur as a linear function of time. That remains a reasonable approach to accounting for changes in storm intensity (i.e., maximum sustained wind speed) over time over the open ocean. However, analyses of tropical storm observations (Ho et al. (1987), Schwerdt et al. (1979), Malkin (1959)) have demonstrated the rate of the decay of the storm intensity over land areas to be nonlinear.

The AOML model (Kaplan and DeMaria, 1995) is based upon the observation that the wind speed decay rate after landfall is proportional to the wind speed. Observations also indicate the wind speed decays to a small, non-zero background speed. Accordingly, the AOML model was formulated as a simple two-parameter exponential decay model, which is a function of the wind speed at landfall and the time since landfall. A correction term that accounts for the proximity of the storm center to the coast is also included; it accounts for differences in the forward speed of storms as they move inland. Model parameters were determined using the best track intensities of all U.S. landfalling tropical storms south of 37° N during the period 1967 to 1993, as determined by the NHC; three cases of storms that made landfall in Florida prior to 1963 were also included in the development database. The model:

$$Vt = Vb + (RV_o - V_b)\, e^{-at} - C$$

where Vt = inland wind in knots at time t,
Vb = a constant, 26.7
R = a constant, 0.90
V_o = coastline wind in knots
a = a constant, 0.095
t = time after coastal crossing in hours

C = correction term to account for proximity to coast and is given by:

$$C = m\,[\,\ln(D)\,] + b$$

where D is the distance from the coast in km ($D^3 1$)
$m = c_1 t\ (t_o - t)$
$b = d_1 t\ (t_o - t)$
$c_1 = 0.0109$, $d_1 = -0.0503$, $t_o = 50$ hrs.

explains 93% of the variance of the NHC best track intensity changes.

A.1.5 Structural Vulnerability Models.

Determination of wind damage contours from tropical storms requires an assessment of structural vulnerability. The American Society of Civil Engineers (ASCE) Standard ANSI/ASCE 7-88 was used to define the design load criteria. Damage (light, moderate, severe) is defined in terms of a ductility ratio, i.e., the ratio of the peak deflection to the deflection at yield. Structural response calculations were performed using single- and multi-degree of freedom engineering models to define the wind speed or, more accurately, the dynamic pressure required to achieve a specified level of damage to a given structure type. Dynamic pressure is calculated directly from the gust velocities determined by the wind model described in Section 1.3.

Not all structures of a given type react exactly the same to a given dynamic pressure loading. Many factors including the architectural style of the structure, its exposure to the wind, the building materials used in construction, and inconsistent building codes affect the response of structures to the dynamic pressure loading. As a result, a probabilistic approach to damage modeling can provide a more realistic estimate of total damage in an area than a deterministic approach, which assigns a discrete damage level to a given structure type for each dynamic pressure level. CATS users can select either of these approaches to damage modeling.

A.1.5.1 The Deterministic Damage Model.

The Deterministic Damage Model assigns a discrete damage level to a given structure type for each dynamic pressure level. This approach is probably best suited to situations where a hurricane is within a few hours of making landfall. The deterministic approach is highly dependent on the accuracy of the hurricane forecast issued by the NHC. The location and severity of damage is determined using a "perfect prog" approach; that is, it is

assumed the *hurricane* forecast verifies perfectly in terms of storm track, intensity, size, and wind distribution. Errors in the forecast of the storm track can lead directly to inaccuracy in the determination of the location of damage. Errors in the forecast of storm intensity can lead to inaccuracy in the determination of damage severity. Errors in the forecast of storm size and wind distribution can lead to errors in the determination spatial variation and extent of wind damage. Because the accuracy of meteorological forecasts tends to increase as the forecast lead time decreases, the "perfect prog" assumption becomes increasingly valid as the time between when the forecast is issued and landfall is reduced. Accordingly, the deterministic approach to damage estimation becomes an increasingly useful method of estimating the magnitude of the disaster as the hurricane gets closer to landfall.

Model results that show projected areas of light, moderate, and severe damage are intersected with population and housing databases (valid 1990) available from the U.S. Census Bureau. These damage levels are defined in terms of the functional loss to a given structure and should not be confused with other measures of damage such as loss of value. Functional loss can be thought of as the level to which a structure type loses its ability to serve its purpose. In the case of a single family, multi-family, or mobile home, the purpose is to serve as the primary source of shelter.

Light damage to one of these structures often causes only minor inconvenience to the resident and does not result in any impact upon structural integrity. Moderate damage can describe a variety of resultant damage manifestations. These can include damage to facade elements, roofs, the interior of the structure, and the frame. While a residential structure subjected to moderate damage may be left temporarily uninhabitable, its structural integrity would not be compromised and it could eventually be suitable for residential use. Severe damage can be understood to include all the manifestations of light and moderate damage, as well as damage that does compromise the integrity of the structure. Any residential structure that suffers severe damage can be thought of as permanently uninhabitable and should be considered a complete loss, both in terms of function and value.

A.1.5.2 The Probabilistic Damage Model.

Probability of damage relationships were constructed using all permutations of the nominal, lower, and upper bound values for each structural parameter, and the dynamic pressure required to achieve damage for each combination. The results of all permutations were used to determine the probability of achieving a specified level of damage for a specific structure type as a function of the dynamic pressure. This allows structural damage to be estimated in a probabilistic sense. That is, for a given dynamic pressure, a given structure type is assigned a damage probability distribution rather than a deterministic prediction of damage.

Probabilistic structural vulnerability models have been developed for a subset of all the structure types for which damage models have been developed. Structure types include three categories of residential structures: single family homes, multi-family homes, and mobile homes. In addition, damage models for these residential structure types differentiate between coastal (less than 100 miles from the coast) and inland locations, in an effort to simulate building code variations based on the exposure to risk of tropical cyclone winds. The definitions of the levels of damage indicated by this analysis are the same as those indicated by the deterministic model.

As with the deterministic model, the probabilistic damage estimation model is highly dependent on the accuracy of the hurricane forecast issued by the NHC. Accordingly, the same potential sources of error and rules for interpreting the results of damage estimations apply for both modeling approaches. Unique to the probabilistic approach is the manner in which the wide range of factors that determine the response of structures to the dynamic pressure loading are addressed and parameterized. Regional variations of building codes, architectural styling, and selection of building materials may cause the response of a typical residential structure in a given area to deviate from that of the idealized structure used to develop the deterministic damage model. In such instances, the probabilistic model may provide more accurate estimations of damage.

It should be noted that models of the type described above have been developed specifically for structures located in the continental United States. These models have subsequently been modified for application to structures in Hawaii. However, for other locations around the world, these models are only representative of a "best guess" about the relative vulnerability of those structures.

A.2 HURRICANE TRACKING MODULE.

A.2.1 Overview.

The Hurricane Tracking Module ingests hurricane observation and forecast data provided by the National Hurricane Center (NHC) in Miami, FL, the Central Pacific Hurricane Center (CPHC) in Honolulu, HI, or the Joint Typhoon Warning Center (JTWC) in Guam in the form of Marine Forecast/Advisory Messages. These messages are disseminated every six hours and can be accessed immediately via the National Weather Service's (NWS) Family of Services (FoS) or the NOAA Weather Wire (NWW), through various university servers on the Internet, or through a commercial vendor of meteorological data. Messages are automatically parsed by the model to extract current and forecast hurricane characteristics, including the current and forecast positions of the storm, its maximum wind speed, and the distribution of wind speeds around the storm.

The Hurricane Tracking Module provides users with the option to graphically determine:

- Current location of a hurricane,
- Previous analyzed positions of a hurricane (beginning with the first advisory message issued by the appropriate forecast center), and
- Forecast positions of a storm.

A.2.2 Mapping Options

All of the capabilities described above can be determined and plotted on the same base map, or select storm parameters can be plotted on a separate map. Users have an option to view the entire track of a storm or just the storm positions indicated in a given advisory. When the option to view the entire storm track is exercised, the Hurricane Tracking Module is passed a file, which has been generated and updated with current observations, and forecast data each time a new advisory is issued. A storm chronology is developed using the observations of storm position that are included in each six-hourly storm advisory. When this option is selected, all the information included in the list above can be determined graphically.

When the option to view the data included in a selected individual advisory is exercised, only the current and forecast positions indicated in that advisory are mapped. Files containing entire storm chronologies or select storm advisories can be selected using the NEW STORM option. This option calls a Storm Selector/Advisory Selector utility that, subsequent to making new selections, returns the user to the Hurricane Tracking Module interface screen.

A.2.3 Special Mapping Scenarios.

Limitations imposed by the data storage format of the database used to define the underlying world base map, and how that data is subsequently used by the GIS can result in problems when attempting to generate maps for certain scenarios. For example, the problems that result when processing advisory messages that define storm tracks that cross the dateline are caused by the way the ARC/INFO GIS looks at the three-dimensional world. ARC/INFO considers the world to be a two-dimensional surface, with the dateline marking its western (left) and eastern (right) edge. As a result, when an advisory defines a storm track that crosses 180° from east-to-west, the map created shows a storm track that terminates at the dateline and then continues on the other edge of the world. A similar end is reached for storms that cross from the other direction.

The first step in handling this problem is to be aware of the nature of the problem. Obviously, this situation will not be a rare one for users with a strong interest in storms that could affect Hawaii or U.S. Territories in the Pacific Basin. This awareness will make it possible for users to avoid making a run of the model before they realize that there could be a problem with mapping the resulting damage bands.

If a user thinks that a storm might cross the dateline during the period covered by the message (72 hours) then they can avoid making a useless model run by simply editing the message. The data that requires editing in these cases are the longitude values. Simply, the hemisphere designation associated with these values needs to be consistent throughout the message. For example, if a storm is located at 179.0 W longitude at 00Z and is forecast to move to 179.5 E longitude by 12Z, the user can edit the message so that 179.5 E is indicated as 180.5 W. The opposite could also be done (i.e., 179.0 W could be indicated as 181.0 E). How the message is edited needs only to depend on what makes less work for the user.

For easy conversion of longitude values, the following method should be used:

- For converting Eastern Hemisphere longitudes to Western Hemisphere longitudes use:
  Degrees West = 180 +(180 - degrees East)

- For converting Western Hemisphere longitudes to Eastern Hemisphere longitudes use:
  Degrees East = 180 +(180 - degrees West).

A.3 STORM SURGE MODULE.

A.3.1 Overview.

Storm surge is the abnormal rise of water generated by a storm, over and above the cyclical astronomical tide. Storm surges can occur in association with tropical storms in the summer and fall, or with large, intense extra-tropical storms whose winds can affect large areas of the coast. For a hurricane, the surge typically has a duration of several hours and affects an area along the coast of about 100 miles. Hurricane storm surges over 20 feet have been observed, although surges of this magnitude are usually limited to hurricanes of Saffir-Simpson Category 4 or 5. In 1969, Hurricane Camille produced a storm surge of approximately 24 feet in the area near Gulfport, Mississippi. The destruction caused by this phenomenon can be significant.

More importantly, however, is the fact that storm surge is the phenomenon most responsible for the loss of life in a hurricane. Nine out of ten people whose lives are lost in hurricanes are killed as a result of rising waters and pounding waves. Areas that may potentially be affected by the storm surge must be evacuated well in advance of when these communities might be cut off from refuge by rising waters.

For this purpose, the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model was developed by the NWS. However, because storm surge is greatly dependent upon the location and intensity of maximum winds associated with the hurricane, estimates of storm surge by SLOSH are highly responsive to changes in storm tracks. When forecast tracks are used as model input to forecast storm surge the forecast location of the peak surge can be expected to show a similar error as the track forecast. Typical track errors of about 100 miles can be expected for 24-hour track predictions issued by the NHC. A displacement of the peak surge estimates of 100 miles would make the results of the model run executed 24 hours earlier of little use to emergency managers.

As a result, the primary use of SLOSH has been for the definition of "flood prone" areas for evacuation planning. These areas are determined by compositing peak estimated surge values at all locations within an envelope. These Maximum Envelopes of Water (MEOWs) have been developed for most of the more highly populated and storm surge prone coastal cities along the coast of the Gulf of Mexico, the East Coast of the United States, and locations in the Caribbean. These MEOWs capture the most probable hurricane scenarios along with some unlikely ones as well.

The basis of the approach to storm surge modeling used in CATS has been demonstrated to provide useful estimates of storm surge related damage and consequences assessments since the 1993 hurricane season. The current storm surge damage module represents an enhancement of the module delivered as part of CATS Version 1.0. A methodology was implemented for automatic selection of the appropriate storm surge basin and MEOW(s) using data available in the regularly scheduled Marine Forecast/Advisory messages issued by the NHC. Using semi-annually updated databases of population, structure types, terrain elevation, road systems, and a high-end

GIS, the damage due to storm surge can be estimated by overlaying water heights indicated by the appropriate MEOW(s). Subtraction of the average terrain height per grid cell from surge height estimations provided by SLOSH (the vertical datum for each of these height measurements is the National Geodetic Vertical Datum (NGVD)) allows for the estimation of the height of the water above the ground in inundated land areas. Damage to property from surge is determined as a function of the height of water. Overlaying the locations of facilities of interest, including schools and hospitals, allows for an assessment of their utility in emergency response procedures.

The following sections provide detailed descriptions of the storm surge phenomenon, the SLOSH model, and how the output of SLOSH is used by CATS to provide estimates of surge damage for the purpose of planning an effective disaster response.

A.3.2 Storm Surge.

If not for the surface stresses provided by the wind on the surface of the ocean fluctuations of sea level on a daily time scale would be controlled solely by the cycles of the astronomical tide. Astronomical tides are the periodic rise and fall of the sea surface due to the gravitational effects of the moon, earth, and sun. During benign weather situations when winds are relatively light, even the effects of wind stress and differential overlying atmospheric pressure do not generate a significant response from the sea surface. However, abnormally high water levels in coastal areas are often observed during periods when relatively strong winds blow over a long fetch for a long period. The storm surges that result from such scenarios can potentially cause significant damage over long stretches of the coastline.

The pattern of intense wind around the center of a hurricane can be small relative to other storms, resulting in storm surges that can be limited to approximately 100 miles of coastline. This is particularly true for hurricanes that make landfall at an angle almost perpendicular to the coast. However, these tropical storms have the potential to produce much higher storm surges than do the more common extra-tropical disturbances (e.g., 'noreasters' that can effect the Atlantic Coast of the U.S.). The high winds and low barometric pressure associated with hurricanes can combine to cause an abnormal rise in sea surface that can exceed 20 feet. If the time of peak surge coincides with the time of local high astronomical tide, the storm surge and its destructive potential are magnified. Local bathymetric and topographic features can further enhance or lessen the magnitude of storm surge.

A.3.2.1 Causal Factors of Storm Surge.

Of the factors that contribute to the generation of storm surge, the most significant is the effect of wind on the underlying sea surface. Winds above the sea surface impart frictional stresses to the underlying water. These frictional stresses are the mechanism for creating a momentum flux from the atmosphere to the ocean. The direct effect of this momentum flux is the generation of horizontal currents in the ocean. Surface currents are generated that flow in the direction of the overlying atmospheric flow. These surface currents, in turn, impart momentum to greater depths causing the formation of subsurface currents. Depending on the intensity and forward speed of the hurricane, these subsurface currents may extend to depths of several hundred feet. The resulting effect is a spiral of horizontal currents that extend deep into the ocean (the current vectors that describe this spiral decrease in magnitude and turn clockwise with increasing depth). While the surface currents flow in the direction of the surface wind, the net transport of water through the column of ocean affected by the overlying atmospheric flow is to the right (in the Northern Hemisphere) and at a 90° angle to the surface current. If these currents are directed toward the coast of a land mass, water begins to accumulate as it is impeded by the continental shelf, leading to a rise in the water surface. The water level maximizes in the vicinity of the shoreline with the slope of the water surface being directly proportional to the magnitude of the wind stress and inversely proportional to the water depth. As a result, coastal areas along which there exists a wide, gradually sloping continental shelf (e.g., the hurricane prone areas of the Gulf of Mexico and the Atlantic Coast) are particularly at risk to the development of significant storm surges.

The "inverted barometer" effect is a secondary factor in the generation of storm surge. The sea surface responds to atmospheric pressure falls at a rate of about a foot per 30 millibars. This effect can account for a rise of one to

two feet near the center of lowest pressure in the hurricane. This effect is modeled explicitly but on a climatological basis (i.e., the atmospheric pressures associated with hurricanes of a given intensity are assigned based on correlation with past events) by the SLOSH model.

The phenomenon known as "wave setup" can also result in water being transported shoreward. The impact of wave setup is limited to the immediate beachfront since large waves do not generally propagate far inland, even after the beach has been inundated. Generally, waves do not add significantly to the area flooded by storm surge and can usually be ignored except for selected coastal configurations. The effect of wave setup is not explicitly addressed by the SLOSH model.

The destructive aspect of "wave run-up" can be significant. However, CATS relies solely on the output of the SLOSH model for determining water levels and, thus, damage. The SLOSH model does not include the effects of 'wave run-up.'

A.3.2.2 <u>Other Controlling Factors.</u>

Other factors can act to either enhance or mitigate the magnitude of the surge generated by strong winds and pressure deficits. The physical configuration of the coastline, including such factors as local bathymetry, orientation relative to the track of an approaching storm, and the shoreline topography can have a significant impact on the resulting storm surge height along a particular coastal area. The physical character of the basin can tend to either amplify or mitigate water levels. For example, if the shoreline of a coastal bay converges toward the head of the estuary it creates an environment conducive to the build up of water in that area. The orientation of the bay can also lead to situations where persistent strong winds from a given direction can generate particularly high storm surges. Areas that lack sheltered bays or convergent shorelines can attenuate the expected surge.

When dealing with the storm surge that can be expected from any given storm, the highest surge levels are generally located to the right of the hurricane track. This is particularly important when the storm makes landfall because the maximum storm surge may vary significantly within a short distance. Maximum surge height is also very sensitive to the location of the maximum wind speeds in a hurricane. The timing of the period of maximum surge relative to the background astronomical tide cycle is important since background tides can either add or subtract from the observed surge height. Issues regarding the effect of track location, the radius of maximum winds, and the periodicity of astronomical tides on observed storm surge heights are addressed in Section 3.5.2.

A.3.3 The SLOSH Model.

The SLOSH model is comprised of a set of equations that govern the change in the height of a water surface. These equations are derived from the Newtonian equations of motion and the continuity equation, applied to a rotating fluid with a free surface. The equations are vertically integrated from the sea bottom to the sea surface. This results in a quasi-onelayer model with a free-surface upper boundary (the sea surface) and a rigid lower boundary (the solid earth). Bathymetric and topographic map data are used to assign a water depth or terrain height to each grid point and these represent the lower boundary. These data are obtained from the National Ocean Survey (NOS) and the United States Geological Survey (USGS), respectively, and are referenced with respect to NGVD.

SLOSH is a diagnostic model in that specifications of the track, size and intensity of the hurricane must be input before the model is executed. A model wind field is produced using these input specifications which, in turn, gives rise to surface stresses of the wind on the water surface. These stresses, friction, and the gradient of atmospheric pressure are the driving forces for moving and piling up water along coastal areas. The configuration of bottom topography in coastal ocean areas largely determines how high water will rise for a given storm. The model computes water height above mean sea level over a geographical area covered by a network of grid points. This network of grid points represents the model domain and is referred to as a basin. The basin is generally defined such that it includes a representation of inland terrain, inland water bodies such as lakes, bays, and estuaries, and a segment of the continental shelf. Since the purpose of the model is to provide estimates of flood potential both at the coast and inland, the coastline, which is a physical boundary, is placed in the interior of the model domain. As a result, the coastal areas of each basin are typically modeled with higher resolution than

are areas covered by open ocean. This allows for a more detailed representation of physical features along the coast that can have significant impact on storm surge inundation patterns. These physical features can include rivers and inlets, islands, and dunes.

Two types of grid systems are currently being used by the NHC when performing storm surge simulations. For some basins, polar coordinate grids are used to define the calculational grid system. The grid is telescoping and contains over 5000 grid points located on lines extending radially outward from a common center. The distance between the grid points increases outward, varying from 0.5 km near the pole to 7.7 km farthest from the pole. This variation in spatial resolution results in higher density coverage over coastal areas, where surge heights are of greatest concern, and fewer grid points over deep water. Sub grid-scale water features such as chokes, cuts, sills, and channels can effect storm surge and can be incorporated into the model through computational overrides. Vertical obstructions such as levees, roads, and spoil banks can also be parameterized.

Several SLOSH basins have been updated with elliptical/hyperbolic grids. The elliptical grid allows for another degree of freedom over the polar grid and allows the grid system to be adjusted, or customized, for use at a particular location. The NWS recommends using the elliptical grid when simulation studies using both grid types are available. Elliptical grids were used to the extent possible in the development of the CATS storm surge damage module.

Time-varying surge heights occur in response to the time-varying horizontal distribution of wind-stress and pressure gradient forces applied to the sea surface. SLOSH uses the model developed by Jelesnianski and Taylor (1973) to specify these forces, which computes pressure and wind direction for a stationary, circularly-symmetric storm. These quantities are subsequently corrected for storm motion.

Astronomical tides are not modeled by SLOSH. A uniform initial elevation of the background water height is assumed as the starting point for surge heights. Surge height studies for individual SLOSH basins are typically conducted using a background initial water level height of one foot above mean sea level. This increased initial water level elevation is due to effects from the storm that can occur well in advance of landfall. Any consideration of astronomical tide is complicated by the requirement to accurately phase the timing of the background tide and that of landfall. A conservative but effective way to include tidal effects is to increment indicated surge heights by an amount equal to the highest tide expected near the time landfall is expected to occur. The superposition of these two components of the total sea surface height is discussed in more detail in Section 3.5.3 of this report.

Jarvinen and Lawrence (1985) conducted an evaluation of the performance of SLOSH using a set of 523 observations of storm surge heights made during 10 hurricanes that made landfall in eight basins. Over 90% of the 523 observations originated from the Gulf of Mexico. The results from that study showed a mean absolute error of 0.43 m, with a small negative bias indicated by the mean error (-0.09 m). Jelesnianski *et al.* (1992) claim model accuracy of ±20% when the hurricane is adequately described. When the model is applied in real-time these errors can increase due to inaccuracies in the characterization of storm parameters including landfall location, track orientation, storm speed, and the spatial distribution of wind in the storm environment. Specific verification experiments performed using SLOSH are discussed in detail in the reference cited immediately above.

A.3.4 Maximum Envelopes of Water (MEOWs).

As was discussed in Section 3.3, SLOSH is a diagnostic model, which relies on the accurate specification of input parameters to provide an accurate estimation of the expected storm surge. Values of specified input parameters are required for both near real-time (i.e., recently observed or analyzed data) and for subsequent forecast periods. Because SLOSH requires the use of forecasted values of input parameters, the accuracy of model estimations is dependent upon the accuracy of those forecasts.

The location and magnitude of storm surge is highly sensitive to the hurricane track and intensity. This fact, combined with the uncertainty associated with hurricane track and intensity forecasts, makes operational use of surge forecasts difficult. Local emergency planners typically need 24 to 48 hours to evacuate residents from an area. Densely populated areas, especially those with limited ingress and egress, often require more than 48 hours

warning. The uncertainty associated with hurricane forecasts with such lead-times directly leads to uncertainty in the accuracy of surge estimates from individual model runs.

To create a product that would provide more useful guidance to emergency managers at the lead-times required for effective evacuation, the NWS developed the concept of a Maximum Envelope of Water (MEOW). A MEOW is a composite of an ensemble of related model runs, comprised of the highest surge value at each grid point. Individual model runs are related in terms of similar storm intensity, heading and forward speed. Storm tracks are typically defined with spacing of approximately 10 to 15 nautical miles in an effort to parameterize the error in the forecast landfall location.

MEOWs have been developed for each basin based upon the local hurricane climatology for that area and are cataloged in terms of (a) Storm Intensity, (b) Storm Heading, and (c) Forward Speed. MEOW studies for Category 4 and 5 storms are typically not performed for northern Atlantic Coast surge basins since they are extremely unlikely to occur there. Hurricanes moving from west to east for these areas are also not expected and, therefore, MEOWs have not been developed for storms with this heading. Hurricanes along the north Atlantic Coast can have forward speeds as high as 60 knots, compared to typical speeds of 10 to 15 knots along the Gulf coast. As a result, MEOWs for storms moving at 60 knots are available for hurricanes tracking through surge basins along the southern New England Coast, for example, but not along the Gulf of Mexico.

A MEOW represents an over-forecast of the area which may be affected by a single impending hurricane. It should be considered an estimate of the area that is "prone" to flooding from the approaching hurricane and not an accurate estimate of the area that will actually flood. It is extremely useful from the standpoint of evacuation, planning, and preparedness. However, the estimation of damage from surge derived using a MEOW represents an upper bound of total surge related damage. The maximum damage indicated in any area should be considered a reliable estimate of the local maximum damage potential.

A.3.5 The CATS Storm Surge Module.

An accurate assessment of the consequences of coastal flooding resulting from the abnormal rise of water associated with an approaching hurricane is required for an effective and efficient response. Such a response can be assured by the pre-positioning of the proper types and amounts of resources appropriate for the magnitude of the disaster. In the case of storm surge, such preplanning for effective disaster response and recovery depends on having access to estimates of flooding extent and depth. The CATS Storm Surge Module was developed to provide users with the capability to estimate event-specific storm surge heights and resultant damage.

Input parameters required by the CATS Storm Surge Module are provided by the Marine Forecast/Advisory Messages issued by the NHC. These data include the location and forecast track of the hurricane and the wind speeds at points within the storm environment. Using these data, CATS determines if and where landfall is forecast to occur and computes the radial wind profiles that describe the two-dimensional wind flow within the storm circulation. From these determinations, the appropriate SLOSH basin and MEOW(s) are identified and are combined to form an estimate of storm surge magnitude and extent. Since the SLOSH model does not include local effects due to time-variant astronomical tide cycles, this component of the expected water height is calculated and the height of the surge indicated by the MEOWs is subsequently modified accordingly. Terrain heights are then subtracted from the water heights indicated over land areas. This provides a measure of the depth of the water over land from which estimates of damage can be determined.

The Storm Surge Module included as part of CATS Version 1.0 automatically determined the most appropriate basin(s) and the MEOW(s) using the latest NHC advisory as input. But because MEOWs represent the area that is prone to flooding and not the area that will actually become flooded, flood extent and depth were overestimated. As a result, determinations of damage and consequences were also overestimated. Additionally, depending on the forecasted storm track, multiple basins and MEOWs could have been selected for mapping and intersection with various demographic and facilities databases in the GIS. In such cases, the overestimation of damage and consequences from a given event was so large as to make it virtually of no utility in planning an effective disaster response.

The Storm Surge Module included as part of Version 2.0 of CATS represents a significant improvement over that included in Version 1.0. Rather than identifying the appropriate basin(s) and MEOW(s) and including that entire area in subsequent analyses only the appropriate geographic sections of MEOW(s) indicated by the analyzed two-dimensional wind field are used. These MEOW sections are then pieced together in a mosaic to define flooded areas that are typically less extensive and shallower at many locations within the flooded area than the Version 1.0 model would have indicated. This modified Storm Surge Module should provide estimates of flood extent and depth that are more appropriate for making useful assessments of damage and consequences before the storm makes landfall. This modified model is described in detail in the following sections.

A.3.5.1 Selection of SLOSH Basin/MEOW.

Algorithms for automatic selection of the appropriate SLOSH basins and MEOWs have been developed and implemented in the CATS software. Using the same input data source as the CATS Wind Damage Model these algorithms select the surge basins through which the hurricane will track during the forecast period, as well as the most appropriate MEOW(s).

The first step in the process is to determine which basins are intersected by the forecast track, regardless of whether or not the storm is forecast to make landfall in that basin. The horizontal extent of each SLOSH basin is defined in terms of its latitudinal and longitudinal boundaries. The storm track is determined from the advisory message using the forecast locations of the storm center during the 72 hour period covered by the advisory. If the closest approach of the storm is within 65 NMI of the center of the basin, that basin is selected as one the user should examine. The domains of surge basins often overlap. If the 65 NMI criterion is met for multiple basins along a given track segment, then MEOWs from both basins are used in the final analysis.

Once the appropriate basin(s) are recommended, the parameters for selection of the appropriate MEOW from each of those basins are examined. These parameters include storm intensity, storm heading, and *forward* speed. Storm intensity is determined from the wind speeds indicated in the advisory message in terms of Categories 1 through 5 as indicated by the Saffir-Simpson Scale. For storm headings, MEOWs are cataloged using sixteen cardinal points (i.e., N, NNE, NE, ENE, etc.). When 360 degrees is divided into sixteen bins, each bin is 22.5 degrees wide. Current storm motion is indicated in the advisories with a resolution of 5 degrees; storm headings at other times are calculated by CATS so that each indicated storm heading falls unambiguously into a heading bin centered on one of the sixteen directions. Current storm speed is read directly from the advisory. Storm speed at other times is calculated by CATS using the forecast positions and times indicated in the advisory.

Since all possible combinations of storm intensity, heading and forward speed are not represented in the development of the MEOWs, it is necessary to find the closest appropriate match to the storm attributes using the existing set of MEOWs. This makes prioritization of the storm attributes necessary. Storm heading is considered the most important attribute in selecting the most appropriate MEOW. Observations have shown that, at certain locations, storms from one direction can cause significant surge while the same storm from a different direction causes relatively little surge. Storm intensity is next in importance, since it is a parameterization of the ability of the storm to move water as a function of the wind stress and atmospheric pressure drop it creates. Finally, storm speed is used to fine-tune the selection. The MEOW selected for a given scenario is the one whose attributes form the closest possible match with those of the current storm.

A.3.5.2 MEOW Mosaic.

An analytical model for determining the continuous radial profile of wind speeds is implemented as part of the CATS disaster analysis system. Each hurricane advisory includes indications of the central pressure of the subject storm and the range from the storm center to where a set predetermined wind speeds are either analyzed (valid at the time the message is issued) or forecast to occur. This discontinuous spatial distribution of wind speeds is provided on a per quadrant basis (i.e., northeast, southeast, southwest, northwest). The wind model takes ambient pressure differences (i.e., the pressure difference between the storm center and the environment immediately outside the storm circulation) and performs iteration on the values of scaling parameters to determine the best fit with data in the advisory. Each time a new advisory is processed the wind model is automatically launched to analyze the best fit radial profile of wind.

The resultant wind profile is used by the Storm Surge Model to determine the areas to the right of the storm track that are experiencing wind speeds within the range of the various Saffir/Simpson Intensity Scale categories. Because MEOWs are cataloged partly as a result of the intensity category indicated by the maximum wind associated with a storm, parts of the storm circulation to the right of the track can be associated with different MEOWs as a function of range from the track. The appropriate MEOW is selected depending on the range of wind speeds analyzed over various distances from the track. If more than one SLOSH basin may be appropriate from which to select these MEOWs, each is examined and the highest surge indicated by the group of MEOWs for a given grid cell is used. Subsequently, the appropriate geographic sections of each of the selected MEOWs are combined into a mosaic. The extent of the mosaic covers only that part of the coast that is affected by winds of at least Category 1 intensity as measured by the Saffir-Simpson Scale.

To the left of the forecast track surge heights are indicated by the appropriate MEOW selected using the maximum winds associated with the storm. These surge heights do not extend beyond the radius of maximum winds as analyzed by the wind model imbedded in CATS. These intensities, along with the storm track heading and speed determine the selection of MEOWs to be included in the storm surge mosaic.

The result of using this approach is that the extent of the coastal flooding that is indicated is less than what would have been estimated using the entire geographical extent of the MEOW (i.e., the entire SLOSH basin). And because a MEOW associated with the maximum wind speed as well as those associated with speeds less than the maximum may have been included as part of the mosaic, the surge depths at those ranges to the right of the track should be more indicative of what one would actually expect to observe.

A.3.5.3 Astronomical Tides.

Astronomical tides are not modeled by SLOSH. Incorporation of this capability into the model would require that the timing of hurricane approach and landfall be modeled with fairly precise accuracy. The period of transition from high to low tide can take place in a matter of only a few hours at times at some locations. Background astronomical tides typically have a range of no more than a few feet along many of the coastal areas most prone to hurricanes and storm surge; at coastal locations along the Gulf of Mexico, astronomical tidal ranges are generally less than one meter. Such a range is often within the margin of error of surge estimates using SLOSH. However, tidal ranges can vary from about two meters along the southern Atlantic Coast to four meters along the southern New England Coast, and to more than seven meters along the Maine Coast. Variations of background sea level height of this magnitude could have a significant effect on patterns of inundation, especially in relatively flat areas where small changes in water height may have a great impact on the extent of flooding. Damage levels incurred due to storm surge can be sensitive to the depth of water; just a few feet of water can make the difference between a relatively minor flooding problem and a family being rendered temporarily homeless. As a result, the types and amounts of materials and supplies required to effectively respond to the effects of a hurricane with storm surge can be impacted significantly by the timing of the event relative to the background astronomical tide cycle. Accordingly, attempts to preposition appropriate resources are also hampered.

Previous studies conducted by the U.S. Army Corps of Engineers and NOAA have examined the problem of how to fold the cyclical effects of tidal variations into the total surge heights estimated by SLOSH. SLOSH model runs have been performed using variations of the initial background water height, typically assumed equal to one foot above mean sea level for MEOW studies. Comparisons of the results of these simulations indicate there tends to be a simple arithmetic relationship between the starting water surface level and the resultant maximum surge elevation along open coastal areas.

Sheltered bays and inlets, and areas on the landward side of barrier islands, tend to exhibit a more complicated response to changes in the starting water surface level. This seems to occur based on the complexity of the terrain, including the effects of natural and man-made barriers and topographic features. Small changes in the water elevation can be sufficient to overtop such a feature as it is represented in the model, which would lead to a large increase in surge elevation behind the feature. To some degree, this tendency can be attributed to the manner in which coastal barriers are represented in the model. For example, a series of discontinuous individual dunes may be represented as a continuous feature of constant elevation along a minimum of one side of a model grid cell. In

reality, the discontinuous nature of these terrain features would tend to mitigate the large changes in landward water elevation indicated by the model.

The CATS Storm Surge Model increments the water elevations derived from MEOWs selected according to the procedure described in Section 3.5.5 by an amount equal to the highest tide predicted to occur within a 12-hour window centered on the forecast time of landfall. The publicly distributed version of the tide prediction model (NTP4) developed by NOS was integrated into CATS to facilitate this calculation. The harmonic constants required to perform these calculations are available for a number of sites along the Atlantic and Gulf Coasts where tide gages have been recording astronomical tidal variations for many years. The CATS Storm Surge Module automatically selects the site or sites within the area analyzed as being likely to experience storm surge and calculates tide height extremes for the period described above. The highest tide at a site is then assumed to occur simultaneously with the landfall of the hurricane. This should result in a final analysis of water elevation for which the potential additive effects of background tidal variations tend to be over-estimated. This approach to modeling tidal effects is part of an overall approach to storm surge modeling that is designed to provide disaster response planners with damage estimates that are accurate, but which may tend to be slightly biased toward a worst case scenario.

A.3.5.4 Subtraction of Terrain Height From MEOWs.

The storm surge for each cell in the SLOSH grid is provided in units of feet above mean sea level (MSL). In order to determine the height of the water above the ground surface it is necessary to subtract the height of the ground above MSL from the surge height indicated for that cell. The terrain data used for this determination is the Digital Terrain Elevation Database (DTED) developed by the USGS, with horizontal resolution of 100 m. This subtraction is performed using the ARC/INFO GIS. The resulting estimates of the extent of inundated land areas are used to determine areas of storm surge damage. The depth of water is related to damage levels as a function of the depth of the water above the first floor of the structure.

A.3.6 Storm Surge Damage Model.

Damage resulting from storm surge is modeled by CATS as a simple function of the depth of the water above the first floor of the structure, which is assumed to be at the level of the local terrain elevation. Damage is analyzed using a three-category mode (i.e., light, moderate, and severe damage), similar to the metric defined to measure damage caused by wind.

The onset of damage occurs rapidly as water levels rise and the progression toward light and moderate damage occurs rapidly. Damage is assumed to begin as the depth of water reaches one foot. The damage level progresses toward moderate damage as the water level reaches above two feet, and severe damage to structures is indicated for areas where the water depth reaches levels greater than ten feet above ground level.

A.3.7 Storm Surge Generalizations.

The following are some highly generalized characteristics of storm surge that can be drawn from results generated by SLOSH:

- More intense storms cause higher surges, all other storm characteristics being the same.
- The maximum surge usually occurs to the right of the storm track at a distance approximately equal to the radius of maximum wind.
- Larger storms (those with a greater radius of maximum wind) cause longer stretches of coastline to be affected by storm surge.
- The extent and height of storm surge at a given location may be highly sensitive to storm track.

- Fast moving storms tend to cause higher surges along the open coast and relatively lower surges in sheltered bays and estuaries. The opposite is true for slow moving storms.

A.4 HURRICANE TRACK AND DAMAGE UNCERTAINTY.

A.4.1 Overview.

The estimates of damage to structures from wind that is provided by the wind damage model have proven to be invaluable to local and Federal emergency managers in planning an effective response to the consequences of a hurricane before it makes landfall. By definition, such estimates of damage and the associated consequences of that damage must be made prior to landfall to be useful for pre-positioning appropriate types and amounts of supplies and resources. There are limiting factors that can negatively impact the accuracy and, therefore, the utility of these estimates when they are made prior to landfall.

Factors limiting the accuracy of damage estimates prior to landfall can be categorized as either model errors or errors in the data used as model input. Model errors can originate from inaccuracies in the estimations of maximum wind gust speeds and dynamic pressure at a location, or from the inability of structural vulnerability models to accurately characterize the variability of resistance to damage for a given structure type. Data used as input to the environment and structural vulnerability models include the observed and forecast values of parameters that describe the storm track, intensity, and spatial distribution of wind speeds around the storm center. Values of these parameters are parsed directly from the Hurricane Forecast/Advisory messages issued by either the NHC, CPHC, or JTWC. The potential errors associated with forecasts of storm intensity and size can be rather substantial and are very difficult to quantify for an individual forecast. However, the NWS has developed the capability to characterize storm track forecast uncertainty in the form of site-specific strike probabilities, and CATS has extended this to model wind speed probabilities and attendant wind damage resulting from the track forecast uncertainty.

CATS users can estimate probabilistic damage to residential structures using a wind speed probability model, WINDP, which is in part a modified application of the NWS' Strike Probability Model STRIKP. For the sake of completeness, the strike probability algorithm is discussed in more detail in Section 4.2. Estimating probabilistic damage to residential structures involves an application of the CATS wind profile model to estimate the probability that a given site will experience wind speeds of various thresholds (i.e., the Wind Speed Probability Model, WINDP). WINDP is discussed in Section 4.3 Section 4.4 addresses how these wind speed probabilities are used to determine damage probabilities using the probabilistic wind damage model discussed in Section 1 of this Appendix.

A.4.2 NWS Hurricane Strike Probability (STRIKP) Model.

Rapid growth of coastal county populations along the Gulf of Mexico and the Atlantic Ocean has taken place in the last few decades, with the population from Texas to North Carolina having grown most rapidly. The coastal county population from Texas to Maine now exceeds 44 million people. In addition to permanent residents, vacation and weekend populations during the peak hurricane season can swell by a factor often.

The NWS attempts to provide a minimum of 12 hours of daylight warning for coastal communities to prepare for a hurricane. Evacuation of large numbers of residents from coastal areas in the path of an approaching hurricane can often require lead times of 20 to 30 hours or more. Both forecast track and storm intensity errors grow as forecast lead time increases, such that the warning false alarm rate could be so high at longer lead-times that warnings could lose their credibility and become of little use as a method of communicating risk to the public. However, the standard warning procedures of the NWS clearly do not provide sufficient lead time required for effective evacuation of many coastal areas.

The NWS developed the STRIKP model for the Atlantic basin based on the work of Jarrell (1981). They subsequently began issuing quantitative estimates of track forecast uncertainty during the 1983 hurricane season.

The strike probabilities determined by the STRIKP model can be interpreted as a quantitative measure of the uncertainty associated with the official forecast tracks issued by the NWS.

A.4.2.1 STRIKP Model Formulation.

Track forecast uncertainty is determined by approximating the spatial distribution of forecast errors using a statistical distribution. The Atlantic Basin was divided into twelve subregions in an attempt to group storms of similar characteristics and to differentiate forecast uncertainty based on location. Errors associated with official forecast tracks were composited relative to the forecast position and forecast direction of storm motion at the discrete forecast lead times of 12, 24, 36, 48, and 72 hours. The resulting distribution of errors is approximated by a bivariate normal distribution, using the composited errors described above for each forecast lead time for different regions of the Atlantic Basin. Probability densities associated with these error distributions decrease with increasing forecast lead time. That is, as the forecast lead-time increases from 12 to 72 hours, the magnitude as well as the scatter of the associated forecast errors increases, resulting in a lower probability density.

A bias exists in the forecast; forecast bias increases as forecast lead time increases. The magnitude and direction of forecast bias relative to the center of the fitted error distribution can indicate a tendency for speed or direction errors in a given region.

To determine strike probabilities for a given site the criteria for a "strike" must be defined. The NWS defines a strike as the center of the storm moving through a circular zone with a radius of 65 nautical miles. The center of the circular zone is offset to the left of the location of interest by approximately 12.5 nautical miles to account for the asymmetries in the wind fields associated with hurricanes. The area within the circular area approximates the size of the region of hurricane force winds associated with a typical hurricane.

A.4.2.2 Interpretation of Strike Probabilities.

The strike probabilities estimated by the NWS using the STRIKP model indicate only the likelihood that a given storm will move over a selected area. No information regarding the intensity of the wind, the height of the resulting storm surge, or the damage potential of the storm is included as part of the strike probability. The NWS uses the STRIKP model to estimate strike probabilities for a selected list of coastal and island locations, as well some points over the open waters of the Atlantic Ocean and Gulf of Mexico. CATS uses algorithms of the STRIKP model as a basis for estimating wind speed probabilities at a variety of sites inland from the coast, in addition to the coastal and island sites used by the NWS. This enables CATS users to generate regional scale maps of the joint probability of wind speed and wind damage that extend well inland. This may allow for a more extensive assessment of potential storm consequences.

The NWS disseminates strike probabilities to the user community in a tabular format. The format of the probability table is designed to enable the user to determine the likelihood that a storm will move over a given location within the subsequent 24, 36, 48, and 72 hours. These total probabilities for a given lead time are determined by adding the values for all preceding time periods.

A.4.2.3 SAIC Wind Probability (WINDP) Model.

The NWS STRIKP model is used in CATS to estimate the probability that a selected location will experience a given wind speed, i.e., WINDP. That probability is then translated into damage severity probabilities for residential housing types at that location using the probabilistic structural vulnerability models for residential structures. The resulting map footprint displays the joint probability of wind speed and wind damage.

As discussed earlier in this section of the Appendix, the NWS defines a "strike" as when a storm enters the circular area within 65 nautical miles of a given site. For the CATS WINDP application, the STRIKP model is run many times, each time using a different distance criterion rather than the 65 nautical mile value used when determining strike probability. These distance criteria are determined for each storm using the wind speed distribution data provided in the Forecast/Advisory message and the analytical radial wind profile model in CATS. The strike probabilities that result from running STRIKP iteratively allow for the determination of the probabilities of experiencing small ranges of wind speed and dynamic pressure at a site.

Spatial distributions of the joint probability of wind speed and wind damage are described by a number of descriptive features. These include the shape of the distribution, the associated probability density, and the offset of the center of the error distribution from the forecast point. The shape of the distribution indicates the spatial tendency of position forecast errors. Distributions may be circular or elliptical. A circular distribution indicates there is no tendency for storm position errors to be in any particular direction relative to the direction of the storm track. An elliptical error distribution which has its major axis oriented along the forecast motion vector indicates errors tend to be as a result of inaccuracies in forecast speed. Elliptical error distributions oriented across the forecast motion vector indicate errors tend to originate as a result of forecast track direction errors.

A.4.3 Structural Damage Probability Assessment.

As was mentioned in Section 4.3, the wind speed probabilities are used in conjunction with the probabilistic structural vulnerability models for residential structures to account for both the uncertainty in hurricane track forecasts and the uncertainty in the response of residential structures to dynamic pressure (wind speed). For each small range of wind speed and dynamic pressure for which wind probabilities are determined there is an associated damage level distribution for residential structures. The product of the wind probability determined for a given location and the probabilities of light, moderate, severe, or no damage associated with that wind speed represents the probability-weighted damage level distribution for that location.

A.5 WEATHER DATA SOURCES FOR INPUT TO CATS HAZARD MODELS.

Quick and easy access to weather data required to satisfy the meteorological input requirements of the various natural and technological hazard models is of paramount importance to users of CATS. In a crisis situation, time is a limiting factor in determining how effectively one can analyze a given hazard scenario, perform subsequent analyses, and process the resulting information in a way that facilitates a quick, effective response. The accuracy of sophisticated modeling approaches implemented in state-of-the-art hazard simulation models ultimately depends on how effectively initial atmospheric conditions have been characterized by available data.

Various meteorological data types are required by all of the models integrated into CATS. The sources of these data currently used as part of the Standard Operating Procedures defined for operation of both CATS-NH and CATS-WMD are discussed below. Although each of the models integrated into the CATS suite of codes has some unique requirements in terms of weather data, these requirements can generally be categorized as being related to (1) hurricanes and typhoons (i.e., wind and storm surge damage), (2) micro-to-mesoscale surface weather conditions (associated with transport and dispersion of NBC agents in the atmosphere), and (3) analysis and forecast data on a meso-to-macroscale (for input to transport and dispersion calculations performed at those scales by HPAC). Access to data from each of these categories of weather data is discussed below.

A.5.1 Hurricane/Typhoon Forecast Advisory Messages.

Observations and forecast data are required as input to both the WIND and STORM SURGE Damage models. These input data are included as part of regularly scheduled advisory messages issued by the various forecast centers. These centers include the National Hurricane Center (NHC) in Miami, FL, the Central Pacific Hurricane Center (CPHC) in Honolulu, HI, and the Joint Typhoon Warning Center (JTWC) in Guam. These messages are disseminated in digital format every six hours (more frequently under special circumstances) and can be obtained from a number of sources. Sources of these data that are generally available to most users are discussed below.

A.5.1.1 Meteorological Data Sources.

A number of sources of meteorological data are available to provide a wide variety of data and narrative forecasts and warnings to users, including hurricane/typhoon advisories and forecasts. These include the National Weather Services (NWS) Family of Services (FoS) and the NOAA Weather Wire (NWW), various university servers on the Internet, and commercial vendors of meteorological data. Government and commercial sources of data provide a wide array of products and can be tailored to the needs of a particular user. These sources can be expensive. Such an expense is usually only justified if the mission of your organization requires frequent or

continuous access to a variety of data types. CATS is applied in times of crisis or when there is reasonable reason to believe that a crisis is imminent. As a result, CATS users typically need only to have access to specific data and warning messages and only on a periodic basis. In lieu of data services that can be costly and provide much more data than are required as input by CATS to determine the physical environment associated with a given hazard, a number of alternative sources are addressed below. These alternative data sources can provide CATS users with multiple options that are readily available using communications technology that is typically available and satisfy the need for redundancy of data sources.

However, the services provided by Government and commercial providers are timely and reliable. CATS is a software tool set generally used operationally by users who rely on the results of analyses to make informed decisions that can mitigate the loss of life and property. The reliability of the access to a required input data source is paramount to the mission of most CATS users and, therefore, often supercedes issues of cost.

A.5.1.2 NOAA Family of Services (FoS).

External user access to near real-time meteorological data is available on a family of medium speed communication services. The Family is divided into seven services: (1) the Public Products Service (which includes Tropical Cyclone Forecast/Advisory Messages required as input to CATS WIND and STORM SURGE damage models), (2) the Domestic Data Service, (3) the International Data Service, (4) the Numerical Data Service, (5) the Direct Connect Service, (6) the Digital Facsimile Service and (7) the AFOS Graphics. All products appearing on the data services are identified by abbreviated headings that conform to World Meteorological Organization (WMO) standards and procedures.

WTNT22 KNHC 130250
HURRICANE BERTHA FORECAST/ADVISORY NUMBER 36
NATIONAL WEATHER SERVICE MIAMI FL
0300Z SAT JUL 13 1996

A HURRICANE WARNING REMAINS IN EFFECT FROM TOPSAIL BEACH NORTH CAROLINA TO CHINCOTEAGUE VIRGINIA...INCLUDING ALBEMARLE AND PAMLICO SOUNDS. A TROPICAL STORM WARNING IS IN EFFECT FROM NORTH OF CHINCOTEAGUE VIRGINIA TO MERRIMACK RIVER MASSACHUSETTS INCLUDING ALL OF THE CHESAPEAKE BAY AND THE LOWER TIDAL POTOMAC...AND ALL OF DELAWARE BAY.

HURRICANE WARNINGS HAVE BEEN DISCONTINUED SOUTH OF TOPSAIL BEACH NORTH CAROLINA. THE HURRICANE WATCH FOR THE LOWER CHESAPEAKE BAY HAS ALSO BEEN DISCONTINUED.

HURRICANE CENTER LOCATED NEAR 35.8N 77.4W AT 13/0300Z
POSITION ACCURATE WITHIN 30 NM

PRESENT MOVEMENT TOWARD THE NORTH NORTHEAST OR 25 DEGREES AT 16 KT

ESTIMATED MINIMUM CENTRAL PRESSURE 987 MB
EYE DIAMETER 20 NM
MAX SUSTAINED WINDS 65 KT WITH GUSTS TO 80 KT
64 KT....... 90NE 90SE 0SW 0NW
50 KT.......125NE 125SE 50SW 50NW
34 KT.......200NE 225SE 100SW 100NW
12 FT SEAS..200NE 225SE 100SW 100NW
ALL QUADRANT RADII IN NAUTICAL MILES

REPEAT...CENTER LOCATED NEAR 35.8N 77.4W AT 13/0300Z
AT 13/0000Z CENTER WAS LOCATED NEAR 35.1N 77.5W

FORECAST VALID 13/1200Z 38.0N 76.0W
MAX WIND 55 KT...GUSTS 65 KT
50 KT...125NE 125SE 25SW 25NW
34 KT...200NE 225SE 50SW 50NW

FORECAST VALID 14/0000Z 41.0N 73.5W
MAX WIND 45 KT...GUSTS 55 KT
34 KT...200NE 225SE 50SW 50NW

FORECAST VALID 14/1200Z 43.5N 68.0W
MAX WIND 40 KT...GUSTS 50 KT
34 KT...200NE 225SE 50SW 50NW

External users may choose to be a direct subscriber to one or more of the services listed above, or they may choose to satisfy their data access requirements by contracting with one of the weather information service companies that are already connected to the FoS. A partial list of such commercial data providers is provided in Section 5.1.4 of this Note. The cost associated with being a direct subscriber to the FoS is often prohibitive and makes the option of contracting with a commercial vendor an attractive option.

For more information about the NOAA/FoS write to:

National Weather Service
Telecommunications & Dissemination Branch W/OSO151
1325 East West
Silver Spring, MD 20910
Attn: Family of Services Program Manager

A.5.1.3 NOAA Weather Wire (NWW).

Weather data from all of the Weather Service Forecast Offices (WSFOs) throughout the United States are collected, processed, and then transmitted to a satellite for broadcast to all user sites. Each NWW customer is equipped with a receive-only micro earth station and receives all available data in a continuous, uninterrupted stream. These earth stations consist of a 30-inch diameter antenna, a low-noise amplifier and a controller. The antenna and amplifier are placed outside and can be roof, wall, or pole mounted for clear line-of-sight to the satellite. They are connected by coaxial cable to the controller that is located inside. Power is only required inside for the controller, eliminating the need for outdoor electrical power. The controller is connected to customer-provided output equipment such as a PC or printer. Customers can capture specific NWW messages for a single, fixed price.

For more information regarding the NWW write to:

GTE Government Systems Corporation
Federal Systems Division
15000 Conference Center Drive
Chantilly, VA 22021-3808
Attn: Marketing Manager, NOAA Weather Wire

Phone: 1-800 633-2340

A.5.1.4 Commercial Vendors.

In lieu of assuming the cost of directly subscribing to the FoS users may choose to satisfy their data access requirements by contracting with one of the weather information service companies that are already connected. A list of some such vendors is provided below:

Alden Electronics
40 Washington Street
Westboro, MA 01581

CompuServe, Inc.
5000 Arlington Centre Blvd.
Columbus, OH 43220

Kavouras, Inc.
6301 34th Avenue South
Minneapolis, MN 55450

WSI Corporation
4 Federal Street
Billerica, MA 01821

Data Transmission *Network* Corporation
9110 West Dodge Road
Omaha, NE 68114

A.5.1.5 World Wide Web (WWW).

Access to the Internet and the World Wide Web is available to anyone with a PC and a fast modem. Web sites for NOAA, including the NWS and a variety of prediction and research centers, can be accessed using graphical browser software (e.g., Netscape or Mosaic). Browsers are often provided free or at low cost to subscribers of national Internet Service Providers such as America Online, Compuserve, or Prodigy. One can use the search capabilities of a given browser to locate weather servers on the WWW, or attempt to connect directly with some of the weather sites on the web using the Universal Resource Locations (URLs) listed below. These weather servers will either provide access to the latest tropical cyclone warning messages directly or they will provide links to sites that will.

National Oceanic and Atmospheric Administration (NOAA)
http://www.noaa.gov

National Weather Service (NWS)
http://www.nws.noaa.gov

National Hurricane Center (NHC)
http://www.nhc.noaa.gov/index.html

NOAA Interactive Weather Information Network (IWIN)
http://iwin.nws.noaa.gov

University of Illinois Weather World
http://www.atmos.uiuc.edu

Florida State University
http://www.met.fsu.edu

This should not be considered a comprehensive list of weather servers on the WWW; sites can and do change addresses while other sites are always being added. However, this list should provide users with enough options to successfully obtain the Forecast/Advisory Messages required to run the WIND and STORM SURGE damage models of CATS. If interested, CATS users can refer to the April/May 1995 issue of *Weatherwise* magazine for information regarding weather servers on the WWW.

Users can access the ever changing list of sites on the Internet that provide weather data by anonymous ftp to: *rtfm.mit.edu* from the file: *weather/data/part1* in the directory: */pub/usenet/news.answers.*. If you do not have access to ftp, you can send an e-mail message to *mail-server@rtfm.mit.edu* with the message:

send /pub/usenet/news.answers/weather/data/part1

as the only text in the message (leave the subject blank). This list is updated every *two* weeks by the National Center for Atmospheric Research (NCAR) in Boulder, CO.

A.5.1.6 Data Provided Automatically via E-Mail

Users can arrange to have data and warning messages sent to them automatically via electronic mail by sending an e-mail message to listserv@vmd.cso.uiuc.edu with the following command in the message body:

sub listname YourFirstName YourLastName

The listname of interest to those looking for information about hurricanes and typhoons is *WX-TROPL*. For a complete description of all available lists use the following command in the message body:

List <Detail/Short/Global)

Users of this service can arrange to receive tropical cyclone warning messages for most areas of the world that experience such storms. Once you have subscribed you will be instructed with more detail how this service can be tailored to your specifications.

A.5.2 Surface Observations.

Surface meteorological data required to satisfy the input requirements of atmospheric transport and dispersion models integrated into CATS-WMD can be accessed manually from a number of sources on the Internet, as well as many of the same general sources of meteorological data discussed in Section 5.1 of this note. Some of the more useful Internet sites are listed below.

In addition, to manual input of these data, the most recent version of CATS includes a utility for automated access of these data. Users can point and click the cursor to graphically select a latitude/longitude pair that coincides with the agent release location. Data from the closest sites at which hourly surface weather conditions are observed and reported are accessed after an automated ftp session is initiated (the ftp address is ftp://ftp.nws.noaa.gov/obs/metar/stations). These data are decoded from the WMO METAR format and indicated to the user. This capability will be demonstrated.

A.5.3 Internet Sites for Surface Weather Data.

Listed below are recommended Internet sites for accessing real-time weather information:

Ohio State University
gopher://twister.sbs.ohio-state.edu:70/1/other-states, or
gopher://geografi.sbs.ohio-state.edu/us.html

University of Illinois
gopher://wx.atmos.uiuc.edu

NOAA Interactive Weather Information Network (IWIN)
http://iwin.nws.noaa.gov

A.5.4 Weather Data from DTRA

BUCSHOT is a Meteorological Data Server (MDS) hosted on machines operated by DTRA. Those interested in learning more about weather data available from BUCKSHOT should ftp to buckshot.spwe.hq.dna.mil and login as "guest". On the directory "/ap3/home/guest/transfer" there are a number of files that can be retrieved that will describe in detail the data that reside there and how to access the data.

APPENDIX B

CHAS WMD EVENT DESCRIPTIONS

This appendix contains a description of the weapons of mass destruction (WMD) events selectable in CHAS Biological and Chemical. These descriptions are contained in a series of tables. Table B-1 contains the burst heights in units of meters for each chemical munition/agent combination.

Table B-1. Heights of burst (meters), vs. chemical agent, munition.

	CHEMICAL AGENTS										
Munitions	GA	GB	GD	GF	HD	VX	TGA	TGD	TGF	THD	TVX
Ballistic Missile	100.	10.	100.	100.	100.	300.	500.	500.	500.	500.	500.
Ballistic Missile w/ Submunitions	2.	2.	2.	2.	2.	2.	0.	0.	0.	0.	0.
100 kg Bomb	15.	2.	15.	15.	15.	15.	15.	15.	15.	15.	15.
250 kg Bomb	15.	2.	15.	15.	15.	50.	50.	50.	50.	50.	50.
500 kg Bomb	15.	2.	15.	15.	15.	100.	100.	100.	100.	100.	100.
122 mm Rockets	15.	2.	15.	15.	15.	15.	15.	15.	15.	15.	15.
90 mm Rockets (aircraft)	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
152 mm Artillery	15.	2.	15.	15.	15.	15.	15.	15.	15.	15.	15.
120 mm Mortar	0.	0.	0.	0.	2.	0.	0.	0.	0.	0.	0.
Landmine	0.	0.	0.	0.	2.	2.	0.	0.	0.	0.	0.
Air Spray Tank	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.
Ground Spray Tank	2.	2.	2.	2.	2.	2.	0.	0.	0.	0.	0.
Small Canister (T)	2.	2.	2.	2.	2.	2.	0.	0.	0.	0.	0.
Large Canister (T)	2.	2.	2.	2.	2.	2.	0.	0.	0.	0.	0.
Air Spray (T)	75.	75.	75.	75.	75.	75.	75.	75.	75.	75.	75.
Ground Spray (T)	2.	2.	2.	2.	2.	2.	0.	0.	0.	0.	0.

(T): terrorist device

Table B-2 provides the payload mass (kg) for each chemical munition/agent combination. A zero mass value indicates that the combination is not available. The total mass released is the product of the payload mass and the dissemination efficiency.

Table B-2. Mass (kg) vs munition, chemical agent.

	Chemical Agents										
Munitions	GA	GB	GD	GF	HD	VX	TGA	TGD	TGF	THD	TVX
Ballistic Missile	500.	500.	500.	500.	500.	500.	500.	500.	500.	500.	500.
Ballistic Missile w/ Submunitions	2.	2.	2.	2.	2.	2.	0.	0.	0.	0.	0.
100 kg Bomb	34.	34.	34.	34.	34.	34.	34.	34.	34.	34.	34.
250 kg Bomb	47.	47.	47.	47.	47.	47.	47.	47.	47.	47.	47.
500 kg Bomb	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.
122 mm Rockets	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
90 mm Rockets (aircraft)	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
152 mm Artillery	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
120 mm Mortar	0.	0.	0.	0.	1.2	0.	0.	0.	0.	0.	0.
Landmine	0.	0.	0.	0.	1.	1.	0.	0.	0.	0.	0.
Air Spray Tank	1200.	120 0.	1200.	1200.	1200.	1200.	1200.	1200.	1200.	1200.	1200.
Ground Spray Tank	1000.	100 0.	1000.	1000.	1000.	1000.	0.	0.	0.	0.	0.
Small Canister (T)	2.	2.	2.	2.	2.	2.	0.	0.	0.	0.	0.
Large Canister (T)	120.	120.	120.	120.	120.	120.	0.	0.	0.	0.	0.
Air Spray (T)	120.	120.	120.	120.	120.	120.	120.	120.	120.	120.	120.
Ground Spray (T)	120.	120.	120.	120.	120.	120.	0.	0.	0.	0.	0.

(T): terrorist device
Military munition dissemination efficiency is 60%
Terrorist munition dissemination efficiency is 60% if explosive driven, 36% if sprayed

Table B-3 indicates the type of source, point, line or spray, by which each chemical munition/agent combination is represented. The line and spray sources are created by means of a locus of point sources. Thus, the line and spray sources typically result in longer running calculations than do the point sources.

Table B-3. Source type vs. munition and agent (P=Point, L=Line, S=Spray).

	Chemical Agents										
Munitions	GA	GB	GD	GF	HD	VX	TGA	TGD	TGF	THD	TVX
Ballistic Missile	L	P	L	L	L	L	L	L	L	L	L
Ballistic Missile w/ Submunitions	P	P	P	P	P	P	P	P	P	P	P
100 kg Bomb	P	P	P	P	P	P	P	P	P	P	P
250 kg Bomb	P	P	P	P	P	L	L	L	L	L	L
500 kg Bomb	P	P	P	P	P	L	L	L	L	L	L
122 mm Rockets	P	P	P	P	P	P	P	P	P	P	P
90 mm Rockets (aircraft)	P	P	P	P	P	P	P	P	P	P	P
152 mm Artillery	P	P	P	P	P	P	P	P	P	P	P
120 mm Mortar	P	P	P	P	P	P	P	P	P	P	P
Landmine	P	P	P	P	P	P	P	P	P	P	P
Air Spray Tank	S	S	S	S	S	S	S	S	S	S	S
Ground Spray Tank	S	S	S	S	S	S	S	S	S	S	S
Small Canister (T)	P	P	P	P	P	P	P	P	P	P	P
Large Canister (T)	P	P	P	P	P	P	P	P	P	P	P
Air Spray (T)	S	S	S	S	S	S	S	S	S	S	S
Ground Spray (T)	S	S	S	S	S	S	S	S	S	S	S

(T): Terrorist Device

Table B-4 provides a number of different parameters for every chemical munition/agent combination. Source sigma is initial distribution of the agent about the point or line/spray, expressed as one standard deviation of a normal distribution. The line length is given for the line and spray sources; the horizontal orientation of the line and spray sources is always normal to the wind direction. A fall angle is associated with the line sources; spray sources are in the horizontal plane. MMD is the mass median diameter of the liquid source droplets; the droplet size distribution is represented as a normal distribution with SIGD being the Litchfield Slope, the ratio between the 84th percentile diameter and the MMD in a log normal distribution. The maximum SIGD allowed is 2.

Table B-4. Vapor sigma, line information, MMD (microns), SIGD vs munition and agent type.

	Source Parameters						
	Source Sigma (m)	Line Length (m)	Fall Angle	Neat Agent		Thickened Agent	
Munitions				MMD	SIGD	MMD	SIGD
Ballistic Missile	15.	300.	70.	500.	1.7	2500.	1.7
Ballistic Missile w/ Submunitions	6.	0.	0.	100.	2.	2500.	1.7
100 kg Bomb	8.	0.	0.	500.	2.	2500.	1.7
250 kg Bomb	10.	75.	45.	500.	2.	2500.	1.7
500 kg Bomb	12.	100.	60.	500.	2.	2500.	1.7
122 mm Rockets	3.56	0.	0.	200.	2.	2500.	1.7
90 mm Rockets (aircraft)	3.56	0.	0.	200.	2.	2500.	1.7
152 mm Artillery	6.	0.	0.	200.	2.	2500.	1.7
120 mm Mortar	3.56	0.	0.	200.	2.	2500.	1.7
Landmine	3.5	0.	0.	200.	2.	2500.	1.7
Air Spray Tank	15.	200.	0.	200.	2.	2500.	1.7
Ground Spray Tank	20.	1000.	0.	200.	2.	2500.	1.7
Small Canister (T)	6.	0.	0.	100.	2.	---	---
Large Canister (T)	6.	0.	0.	100.	2.	---	---
Air Spray (T)	15.	2000.	0.	200.	2.	2500.	1.7
Ground Spray (T)	20.	2000.	0.	200.	2.	---	---

(T): Terrorist Device

Table B-5 contains the specifications for biological munition/agent combinations included in CHAS. Explanation of quantities is as above. The release mass of active agent is the product of the payload mass, the dissemination efficiency and the agent purity.

Table B-5. Biological agent data.

INDIVIDUAL SUBMUNITIONS						
Agent	Dissemination Efficiency	Source Type	Payload Mass (kg)	Sigma (m)	HOB (m)	Number per Munition
Botulinum toxin	60.0%	P	0.039	5.	2.	2000
Anthrax	60.0%	P	0.039	5.	2.	2000

SPRAY						
Agent	Dissemination Efficiency	Source Type	Payload Mass (kg)	Sigma (m)	HOB (m)	Line Length (m)
SEB	10%	L	45.	10.	70.	4,000
Botulinum toxin	10%	L	45.	15.	50.	4,000
Anthrax	10%	L	1200.	25.	50.	4,000
Terrorist Canister, Small						
Anthrax	1.0%	P	2.	5.	2.	
Botulinum toxin	1.0%	P	2.	5.	2.	
Terrorist Canister, Large						
Anthrax	1.0%	P	200.	5.	2.	
Botulinum toxin	1.0%	P	200.	5.	2.	
Terrorist Spray Air						
Anthrax	0.5%	L	200.	25.	75.	4,000
Botulinum toxin	0.5%	L	200.	25.	75.	4,000
SEB	0.5%	L	200.	25.	75.	4,000

Terrorist agent purity is taken to be 0.1%
Military agent purity is taken to be 99%

APPENDIX C

DATABASE CODES

This appendix contains a listing of the majority of databases supplied with CATS. The listing includes the date on which the last update was performed. It also provides the meaning for the metadata codes for each database field. These codes appear in the table box when the identify tool is used to query data associated with an object associated with a specific theme in the active View.

C.1 "AIRPORT" DIRECTORY.

C.1.1 Airport Databases.

Table C-1. Airport Databases.

DATABASE FILE NAME (date of last updates = 03/04/92)	NUMBER OF RECORDS; DATABASE NAME
airports.dbf	1414; Airports (US & Territories)
airairfo.dbf	104; Air Force Airports
airarmy.dbf	25; Army Airports
airnavy.dbf	60; Naval Air Bases
airprvte.dbf	159; Private Airports
airpubli.dbf	1066; Public Airports

The following field names and meanings are common to all airport databases.

Table C-2. Metadata codes common to all airport databases.

FIELD NAME	FIELD MEANING
SITENUM	Landing Facility Site Number
FACTYPE	Landing Facility Type; AIR = Airport, BAL = Balloonport, SEA = Seaplane Base, GLI = Gliderport, HEL = Heliport, STO = Stolport, ULT = Ultralight
LOCID	Location ID
FAAREG	FAA Region Code; AAL = Alaska, ACE = Central, AEA = Eastern, AGL = Great Lakes, AIN = International, ANE = New England, ANM = Northwest Mountain, ASO = Southern, ASW = Southwest, AWP = Western-Pacific
STATEABBRV	State Abbreviation
COUNTYNAME	County Name
CITY	Nearest City or Town
FACNAME	Landing Facility Name
OWNTYPE	Airport Ownership Type; PR = Privately owned, MA = Air Force owned, MN = Navy owned, MR = Army owned, PU = Publicly owned
FACUSE	Facility Use; PU = Opened to public, PR = Private
FACOWNER	Owner Name
ADDRESS	Owner Street Address
ADDRESS2	Owner City, State, and Zip
PHONE	Phone Number
ELEVATN	Airport Elevation in Feet
TRPATALT	Traffic Pattern Altitude
CHART	Aero/Sec Chart Located on
DISTOCTY	Distance from Airport to City

FIELD NAME	FIELD MEANING
DIRECTN	
ARTCCID	Boundary ARTCC Name
ARTCCNAM	ARTCC Name
TIEINFSS	Tie-In FSS on Site
ALTFSSID	
CERTYPE	Airport Cert. Type and Date
CENTRY	Entry for Customs (Yes/No)
CLANDING	Custom Landing Rights (Yes/No)
JOINTUSE	Mil/Civil Joint Use Agreement (Yes/No)
MILANDRT	Military Landing Rights (Yes/No)
EMERSTAT	Emergency Status
MILDEPT	Military Dept.; R = Army, A = Air Force, N = Navy
FUELTYPE	Fuel Type; 80 = Grade 80 Gas (Red), 100 = Grade 100 Gas (Green), 100LL = Gr. 100LL Gas (Low Lead), 115 = Grade 115 Gas, A = Jet A Kero. Fz.Pt. -40C, A1 = Jet A-1 Ker. Fz.Pt. -50C, A1+ = Jet A-1 Ker/Ice Inhibitor, B = Jet B Freez.Pt. -50C, B+ = Jet B/Ice Inhibitor, MOGAS = Automotive Gasoline
AIRFREPS	Airframe Repair Service
ENGREP	Engine Repair Availability
OXBOT	Bottled Oxygen Available
OXBULK	Bulk Oxygen Available
LITSCHED	Airport Lighting Schedule
ATCTHERE	Air Traffic Tower on Site (Y/N)
UNICOM	Unicom Frequencies Available
CTAFREQ	Common Traf. Advisory Freq.
LENSCOLR	Lens Color of Beacon; CG = Clear Green (Lighted Land), CY = Clear Yellow (Lighted Seapl.), CGY = Clear-Green-Yellow (Heli.), SCG = Split-Clear-Green (Military), C = Clear (Unlighted Land), Y = Yellow (Unlighted Seaplane), Space = None
SENGENAV	Engine Gen. Aviation Aircraft
MULTIENG	Multi-Engine Gen. Aviation
JETGENAV	Jet General Aviation
GENAVHEL	General Aviation Helicopter
MILAIRCR	Military Aircraft
ANCOMSER	Commercial Services
ANAIRTAC	Air Taxi
ANGENAVL	General Aviation Local Ops.
ANGENAVI	General Aviation Itinerant
ANMILAIR	Military Aircraft Operations
NUMPAD	
NUMRWY	
RWYID	Runway Identification
LENGTH	Runway Length in Feet
WIDTH	Runway Width in Feet
SURFTYPE	Surface Type/Condition; CONC = Portland Cement Concrete, ASPH = Asphalt, SNOW = Snow, ICE = Ice, MATS = Pierced Steel Planking, TREA = Oiled, GRAV = Gravel, TURF = Grass/Sod, DIRT = Natural Soil, WATE = Water, WOOD = Wood, G = Good, F = Fair, P = Poor

FIELD NAME	FIELD MEANING
SURTREAT	Runway Surface Treatment; GRVD = Saw-Cut or Plastic Grooved, PFC = Porous Friction Course, AFSC = Aggregate Friction Seal, RFSC = Rubberized Friction Seal, WC = Wire Comb or Wire Tine, NONE = No Special Surface Treatment
PAVECLAS	Pavement Classification
LITEDGIN	Rwy. Lights Edge Intensity; HIGH = High, MED = Medium, LOW = Low, NSTD = Non-Standard Lighting System, NONE = No Edge Lighting System
BASENDID	Base End Identifier
BEILSTYP	Instrument Landing System; LOCALI = Localizer, LDA = Localizer-Type Direct. Aid, ISMLS = Interim Microwave I.L.S., ILS/DM = I.L.S./Dist. Measure Equip., SDF/DM = Direct. Fac. Dist. Measure, LOC/DM = Localizer D.M.E., LOC/GS = Localizer/Glide Slope, LDA/DM = Local. Direct. Aid D.M.E., ILS = Instrument Landing System, MLS = Microwave Landing System, SDF = Simplified Directional Fac.
BERWYMRK	Base End Runway Mark. (Type); PIR = Precision Instrument, NPI = Non-Precision Instrument, BSC = Basic, NRS = Numbers Only, NSTD = Non-Standard, BUOY = Buoy (Seaplane Base), STOL = Short Take-off and Landing, NONE = None
BEMRKCON	Base End Runway Mark. (Condition); see above codes for SURFTYPE field
BEARRDEV	Reciprocal End Arrest Dev.
BERVV	Runway Visibility Val. Equip. (Yes/No)
BEAPLITE	Approach Light System (Yes/No)
BEIDLITE	Identifier Lights (Yes/No)
BECTRLIT	Centerline Lights Available (Yes/No)
BETCHLIT	Touchdown Lights Available (Yes/No)
BERWYCAT	Runway Category/Base-End; B (V) = Non-Utility Rwy/Visual Ap, A (NP) = Utility Rwy/Non-Prec. App, C = N/Prec. App Vis. Min. >3/4 Mi., OUR = Precision Instrument Rwy., A (V) = Utility Runway/Visual App.
RECENDID	Identifier
REILSTYP	Instrument Landing System; see above codes for BEILSTYP field
RERWYMRK	Rec. End Runway Mark (Type); see above codes for BERWYMRK
REMRKCON	Rec. End Runway Mark (Condition); see above codes for SURFTYPE field
REARRDEV	Base End Arresting Device
RERVV	Visibility Value Equipment (Yes/No)
REAPLITE	Approach Light System (Yes/No)
REIDLITE	Rec. End Identifier Lights (Yes/No)
RECTRLIT	Rec. End Centerline Lights (Yes/No)
RETCHLIT	Rec. End Touchdown Lights (Yes/No)
RERWYCAT	Rec. End Runway Category; see above codes for BERWYCAT field
RWYRANK	
OETRG	OET Region Code (1-11)
UPDATE	
SYSID	
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
COUNTER	Record Counter

C.1.2 Airports <= 5000 Ft. (airfield.dbf).

Table C-3. Airports <= 5000 ft metadata codes.

Number of records	12069
Date of last update	04/29/92

FIELD NAME	FIELD MEANING
CITY	City Name
STATEABBRV	State Abbreviation
AIRCRAFTNO	
PLANESMENG	
PLANESJETS	
HELICOPTRS	
HELIPADS	
RUNWAYSNO	
RUNWAYLNTH	Length of runway in feet
RUNWAYWDTH	Width of runway in feet
ELEVATION	
REGION	FEMA Region Code
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
SMSACODE	Metropolitan Statistical Area Code
COUNTYNAME	County Name
FIPST	FIPS State Code
COUNTYCODE	FIPS County Code
SITETYPE	Landing Facility Type; AIR = airport, BAL = Balloonport, SEA = Seaplane Base, GLI = Gliderport, HEL = Heliport, STO = Stolport, ULT = Ultralight
UNIQUEID	
MILITARYOK	(Y, N, X)
FAAREGION	FAA Region Code; AAL = Alaska, ACE = Central, AEA = Eastern, AGL = Great Lakes, AIN = International, ANE = New England, ANM = Northwest Mountain, ASO = Southern, ASW = Southwest, AWP = Western-Pacfic
OETREGION	OET Region Code (1-10; 11=AK)
OWNERCODE	Ownership Type; PR = Privately owned, MA = Air Force owned, MN = Navy owned, MR = Army owned, PU = Publicly owned
USAGECODE	Usage Code (PP)
FAANUMBER	
NAME	Landing Facility Name
FRAMERPAIR	Airframe Repair Service (Major, Minor, None, XXXX)
ENGNERPAIR	Engine Repair Availability (Major, Minor, None, XXXX)
OXYGENBOTT	Bottled Oxygen Available (None, High, XXXXXXXX)
OXYGENBULK	Bulk Oxygen Available (None, High, XXXXXXXX)
COUNTER	Record Counter

C.1.3 Air Flight Service Stations (flightss.dbf).

Table C-4. Air Flight Service Stations metadata codes.

Number of records	651
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
OUTIDT	Communications Outlet ID
OUTTYP	Communications Outlet Type
NAVIDT	Associated Navaid ID
NAVTYP	Associated Navaid Type; R = NDB, C = Vortac, V = VOR, D = VOR/DMS, K = Consolan, F = Fan Marker, L = Low Frequency Range, M = Marine NDB, O = VOT, U = UHF/NDB, RD = NDB/DME, T = Tacan
CITY	Navaid City
STATEABBRV	Navaid State Abbreviation
NAME	Navaid Name
OUTCITY	Comm. Outlet City
OUTST	Comm. Outlet State Abbr.
OUTNAME	Comm. Outlet Name
OUTCODE	Comm. Outlet Code
OUTCALL	Comm. Outlet Call
OUTFREQ	Comm. Outlet Frequency
FSSIDT	Flt. Service Station ID
FSSNAME	Flt. Service Station Name
ALTIDT	Alternate FSS ID
ALTNAME	Alternate FSS Name
OPHOURS	Operational Hours
OWNAME	Owner Name (FAA)
CHARTS	Charts
TIMEZN	Time Zone
STATUS	Status
STDATE	Status Date
OETREG	OET Region
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
COUNTER	Record Counter

C.1.4 Helicopter Pads (heliport.dbf).

Table C-5. Helicopter pad metadata codes.

Number of records	3536
Date of last update	04/29/92

FIELD NAME	FIELD MEANING
CITY	City Name
STATEABBRV	State Abbreviation
AIRCRAFTNO	
PLANESMENG	
PLANESJETS	
HELICOPTRS	
HELIPADS	
RUNWAYSNO	
RUNWAYLNTH	Length of Runway in Feet
RUNWAYWDTH	Width of Runway in Feet
ELEVATION	
REGION	FEMA Region Code

LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
SMSACODE	Metropolitan Statistical Area Code
COUNTYNAME	County Name
FIPST	FIPS State Code
COUNTYCODE	FIPS County Code
SITETYPE	Landing Facility Type; AIR = airport, BAL = Balloonport, SEA = Seaplane Base, GLI = Gliderport, HEL = Heliport, STO = Stolport, ULT = Ultralight
UNIQUEID	
MILITARYOK	(Y, N, X)
FAAREGION	FAA Region Code; AAL = Alaska, ACE = Central, AEA = Eastern, AGL = Great Lakes, AIN = International, ANE = New England, ANM = Northwest Mountain, ASO = Southern, ASW = Southwest, AWP = Western-Pacfic
OETREGION	OET Region Code (1-10; 11=AK)
OWNERCODE	Ownership Type; PR = Privately owned, MA = Air Force owned, MN = Navy owned, MR = Army owned, PU = Publicly owned
USAGECODE	Usage Code (PP)
FAANUMBER	
NAME	Landing Facility Name
FRAMERPAIR	Airframe Repair Service (Major, Minor, None, XXXX)
ENGNERPAIR	Engine Repair Availability (Major, Minor, None, XXXX)
OXYGENBOTT	Bottled Oxygen Available (None, Low, High/Low, XXXXXXXX)
OXYGENBULK	Bulk Oxygen Available (None, High/Low, XXXXXXXX)
COUNTER	Record Counter

C.2 "CEMETARY" DIRECTORY.

C.2.1 VA Cemetary Sites (vacemety.dbf).

Table C-6. VA Cemetary Sites metadata codes.

Number of records	114
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
ZIP	Zip Code
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
NAME_ADDR	Name/Address of Cemetary
CITY	City Where Cemetary is Located
STATE	State Abbreviation
STAT_NUMB	Unique VA Facility Identifier
REGION	VA Region; 1 = MA, MD, ME, NJ, NY, PA, VA, WV, 2 = IA, IL, IN, KS, KY, MI, MN, MO, NE, OH, SD, WI, 3 = AL, AR, FL, GA, LA, MS, NC, OK, PR, SC, TN, TX, 4 = AK, AZ, CA, CO, HI, NM, OR
RESERVED	Number of Reserved Plots at Cemetary

AVAILABLE	Number of Available Plots at Cemetary
SERV_STAT	Code of VA Facility which Services Cemetary
SERV_NAME	Name of VA Facility which Services Cemetary
EMERG_COMM	Emergency Communications
COUNTER	Record Counter

C.3 CHEMICAL PLANTS "CHEMPLNTS" DIRECTORY.

C.3.1 Chemical Plants (chemical.dbf).

Table C-7. Chemical Plants metadata codes.

Number of records	3646
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
FIPCNTY	FIPS County Code
FIPST	FIPS State Code
COMPANY	Company Name
STREET	Company Street Address
MAILADD	Company Mailing Address
CITY	City Name
STATEABBRV	State Abbreviation
ZIP	Zip Code
PHONE	Telephone Number
OFFICER	Person in Charge
STARTYR	Starting Year of Business
SALES	Annual Sales, $100000
EMPLH	Number of Employees at This Site
SIC8	DUNS Product Code
STATUSI	
MNFTGI	Manufacturing Indicator; 0 = Manufacturing Done Here, 1 = No Manufacturing Done Here
STCDE	DUNS State Code
CNTYCDE	DUNS County Code
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
POINTCDE	
DESCRIPTN	Description of Product
COUNTER	Record Counter
SIC4	4-Digit SIC Industry Code
SIC6	DIMS 6-Digit Code
PRODUCT	Name of Product

C.4 COMMUNICATIONS "COMMS" DIRECTORY.

C.4.1 EBS AM-FM-TV EMP (amfmtvem.dbf).

Table C-8. EBS AM-FM-TV EMP EBS AM-FM-TV EMP metadata codes.

Number of records	104
Date of last update	02/03/92

FIELD NAME	FIELD MEANING
CITY	City Name
STATEABBRV	State Abbreviation
ZIPCODE	Zip Code
REGION	FEMA Region
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
MSACODE	Metropolitan Statistical Area Code
COUNTYCODE	FIPS County Code
CSIGN	Call Sign
COMPNYNAME	Company Name
ADDRESS	Company Address

C.4.2 PBS AM-FM, TV All (ebsbroad.dbf).

Table C-9. PBS AM-FM, TV All metadata codes.

Number of records	12050
Date of last update	02/03/92

FIELD NAME	FIELD MEANING
NODENAME	Actual Name of the Node
CCFINDCTR	Critical Communication Facility Indicator (Yes/No)
PREDSTATUS	Predicted Status Code; 0 = Unknown, 1 = No Damage, 2 = Moderate Damage, 3 = Severe Damage
ACTSTATUS	Actual Status Code; 0 = Unknown, 1 = No Damage, 2 = Moderate Damage, 3 = Severe Damage
STATEABBRV	FIPS State Abbreviation
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
MEDIATYPE	Media Type Code; AM = AM Radio, FM = FM Radio, TV = Television
COUNTER	Record Counter

C.4.3 Network (network.dbf).

Table C-10. Network metadata codes.

Number of records	106
Date of last update	02/03/92

FIELD NAME	FIELD MEANING
NETABBNAME	Abbreviated Network Name
NETFULNAME	Network's Full Name
AGENCY	Abbreviated Agency Name
NETWORKPOC	Network Point of Contact
DESCRIPTN	Description of Resource
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)

C.4.4 Communications Nodes (nodesnet.dbf).

Table C-11. Communications Nodes metadata codes.

Number of records	8480
Date of last update	02/03/92

FIELD NAME	FIELD MEANING
NODENAME	Actual Name of the Node
CCFINDCTR	Critical Communication Facility Indicator (Yes/No)
PREDSTATUS	Predicted Status Code; 0 = Unknown, 1 = No Damage, 2 = Moderate Damage, 3 = Severe Damage
ACTSTATUS	Actual Status Code; 0 = Unknown, 1 = No Damage, 2 = Moderate Damage, 3 = Severe Damage
DESCRIPTN	Description of Resource
CITY	City Name
STATEABBRV	FIPS State Abbreviation
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
NETABBNAME	Abbreviated Network Name
COUNTER	Record Counter

C.5 "COUNTIES" DIRECTORY

C.5.1 County Locations by Centroid (cntycent.dbf)

Table C-12. County Locations by Centroid.

Number of records	3115
Date of last update	03/04/92

FIELD NAME	FIELD MEANING
FIPST	FIPS State Code
COUNTYCODE	FIPS County Code
STATEABBRV	State Abbreviation
STATENAME	State Name
COUNTYNAME	County Name
LONGITUDE	Longitude (decimal degrees)
LATITUDE	Latitude (decimal degrees)
COUNTER	Record Counter

C.6 "DAMS" DIRECTORY.

C.6.1 Irrigation Dams (damirig.dbf).

Table C-13. Irrigation Dams metadata codes.

Number of records	488
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
CITY	City Name

STATEABBRV	State Abbreviation
MAXCAPCTY	Maximum Storage in AcreFeet
NORMCAPCTY	Normal Storage in AcreFeet
POPULATION	Population of Nearest Downstream Town
REGION	FEMA Region Code
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
MSACODE	Metropolitan Statistical Area Code
COUNTYCODE	FIPS County Code
DAMPURPOSE	Purpose of Dam (combinations); C = Flood Control, D = Debris Control, H = Hydroelectric, I = Irrigation, N = Navigation, O = Other, P = Stock and Small Farm Pond, R = Recreation, S = Water Supply
OWNERCODE	Ownership Code; G = Federal Government
FEDREGCODE	FEMA Federal Region Code
HAZARDCODE	Downstream Hazard Potential; 1 = High Risk, 2 = Significant Risk, 3 = Low Risk
SPILLCODE	Dam Spillage Code; C = Controlled, U = Uncontrolled, N = None, O or Space = Not Provided
NAME	Name of Dam
WATERNAME	Name of Body of Water
DAMOWNER	Dam Owner; DOD USA, DOI BIA, DOI BLM, DOI BR, DOI FWS, DOI NPS, DOJ BOP, IBWC, TVA, USDA FS, or USDA SC
COUNTER	Record Counter

C.6.2 Water Supply Dams (waterdam.dbf)

Table C-14. Water Supply Dams metadata codes.

Number of records	9745
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
CITY	City Name
STATEABBRV	State Abbreviation
NORSTORAGE	Normal Storage in Acrefeet
POPATRISK	Population at Risk
MAXSTORAGE	Maximum Storage in Acrefeet
REGION	FEMA Region Code
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
COUNTYCODE	FIPS County Code
DAMUSES	Dam Use Combinations; C = Flood Control, D = Debris Control, H = Hydroelectric, I = Irrigation, N = Navigation, O = Other, P = Stock or Small Farm Pond, R = Recreation, S = Water Supply
OWNERCODE	Dam Ownership Code; C = Corps of Engineers, G = Federal Government, N = Non-Federal
REGULATEDC	Dam Federally Regulated; Y = Yes, N = No, Blank = Not Provided
HAZARDCODE	Downstream Hazard Potential; 1 = High Risk, 2 = Significant Risk, 3 = Low Risk, Blank = Data Not Provided

SPILLCODE	Spillage Code; U = Uncontrolled, C = Controlled, N = None, Blank = Data Not Provided
WATERID	
DAMOWNER	Owner of Dam
DAMNAME	Name of Dam
STRUCTURE	Structure Type Combinations; CB = Buttress, ER = Rockfill, MV = Multi-Arch, OT = Other, PG = Gravity, RE = Earth, VA = Arch, XX = Unknown
DAMHEIGHT	Structural Height of Dam in Feet
DISTANCE	Distance to Nearest Downstream Town
REGBASIN	Region and Basin Code
COUNTER	Record Counter
OWNERCLASS	Ownership

C.7 "ENERGY" DIRECTORY.

C.7.1 Coal Mines (coal.dbf).

Table C-15. Coal Mines metadata codes.

Number of records	738
Date of last update	02/08/92

FIELD NAME	FIELD MEANING
FIPSSTATE	FIPS State Code
QUALIFIER	Direction Indicator (N, S, E, W)
FIPSCOUNTY	FIPS County Code
MINECODE	
SYSTEMTYPE	(For DOE Internal Use Only)
RECORDTYPE	(For DOE Internal Use Only)
BLAST	Code for Level of Damage; SEV = Severe, MOD = Moderate, LIT = Light, NON = None, Blank = None
YYMM	Currency of Data (YYMM)
LASTUPDATE	Date of Last Modification
USERID	User who Updated this Record
STATUS	(For DOE Internal Use Only)
TAG	Mark/Flag for this Record
DAMTYPE	(For DOE Internal Use Only)
LBLAST	Blast Damage Indicator
LFIRE	Fire Damage Indicator
RADIATION	Radiation Damage Indicator
EARTHQUAKE	Earthquake Damage Indicator
HURRICANE	Hurricane Damage Indicator
FLOOD	Flood Damage Indicator
DROUGHT	Drought Damage Indicator
OTHER	Other Damage Indicator

FIELD NAME	FIELD MEANING
PAD	Petroleum Administration for Defense (PAD) District; 1 = PAD District I - East Coast area, Appalachian #1 area, 2 = PAD District II - Appalachian #2 area, Indiana-Illinois-Kentucky area, Minnesota-Wisconsin-North and South Dakota area, Oklahoma-Kansas-Missouri area 3 = PAD District III - Texas Inland area, Texas Gulf Coast area, Louisiana Gulf Coast area, North Louisiana-Arkansas area, New Mexico, 4 = PAD District IV - Rocky Mountains 5 = PAD District V - West Coast
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
ZIPCODE	Zip Code
NERC	National Electric Reliability Council Area; ECAR = East Central Area Reliability Council, ERCT = Electric Reliability Council of Texas, MAAC = Mid-Atlantic Area Council, MAIN = Mid-Atlantic Interpool Network, MAPP = Mid-Continent Area Power Pool, NPCC = Northeast Power Coordinating Council, SERC = Southeastern Electric Reliability Council, SPP = Southwest Power Pool, WSCC = Western Systems Coordinating Council
STATEABBR	State Abbreviation
COUNTYNAME	County Name
FEMAREGION	FEMA Region Code
COMPNAME	Company Name
MINENAME	Facility Name
CITY	City Name
CONTACT	
PHONE	Telephone Number
UNION	Union Affiliation
TYPECOMP	
OPERTYPE	Operation Type
MINETYPE	Mine Type; S = Surface Mine, U = Underground Mine
BOMDIST	BOM Coal District, 1-25
PRODUCTION	Coal Production in Short Tons
RECOVER	Recoverable Reserves in Short Tons
MANHRSAN	
DAYSWORKAN	
AVGMANDALY	
MANSHIFTAN	
SHIFTLEN	
PRODCAPCTY	Production Capacity (Short Tons/Day)
EMPLOYMENT	Total Employment
COUNTER	Record Counter

C.7.2 Coke Plants (coke.dbf).

Table C-16. Coke Plants metadata codes.

Number of records	35
Date of last update	02/28/92

FIELD NAME	FIELD MEANING
FIPSSTATE	FIPS State Code
QUALIFIER	Direction Indicator (N, S, E, W)
FIPSCOUNTY	FIPS County Code
COMPANYID	Unique ID Used Within EIA
SYSTEMTYPE	(For DOE Internal Use Only)
RECORDTYPE	(For DOE Internal Use Only)
BLAST	Code for Level of Damage; SEV = Severe, MOD = Moderate, LIT = Light, NON = None, Spaces = None
YYMM	Currency of Data (YYMM)
LASTUPDATE	Date of Last Modification
USERID	User who Updated this Record
STATUS	(For DOE Internal Use Only)
TAG	(For DOE Internal Use Only)
DAMTYPE	(For DOE Internal Use Only)
LBLAST	Blast Damage Indicator
LFIRE	Fire Damage Indicator
RADIATION	Radiation Damage Indicator
EARTHQUAKE	Earthquake Damage Indicator
HURRICANE	Hurricane Damage Indicator
FLOOD	Flood Damage Indicator
DROUGHT	Drought Damage Indicator
OTHER	Other Damage Indicator
PAD	Petroleum Administration for Defense (PAD) District; 1 = PAD District I - East Coast area, Appalachian #1 area, 2 = PAD District II - Appalachian #2 area, Indiana-Illinois-Kentucky area, Minnesota-Wisconsin-North and South Dakota area, Oklahoma-Kansas-Missouri area 3 = PAD District III - Texas Inland area, Texas Gulf Coast area, Louisiana Gulf Coast area, North Louisiana-Arkansas area, New Mexico, 4 = PAD District IV - Rocky Mountains 5 = PAD District V - West Coast
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
ZIPCODE	Zip Code
NERC	National Electric Reliability Council Area; ECAR = East Central Area Reliability Council, ERCT = Electric Reliability Council of Texas, MAAC = Mid-Atlantic Area Council, MAIN = Mid-Atlantic Interpool Network, MAPP = Mid-Continent Area Power Pool, NPCC = Northeast Power Coordinating Council, SERC = Southeastern Electric Reliability Council, SPP = Southwest Power Pool, WSCC = Western Systems Coordinating Council
STATEABBR	State Abbreviation
COUNTYNAME	County Name
FEMAREGION	FEMA Region Code
COMPNAME	Company Name
PLANTNAME	Facility Name
CITY	City Name
CONTACT	
PHONE	Telephone Number

FIELD NAME	FIELD MEANING
COKEPRODUC	Coke Production (Short Tons)
COALCONSUM	Coal Consumption (Short Tons)
COALSTOCKS	Coal Stocks (Short Tons)
COKESTOCKS	Coke Stocks (Short Tons)
COUNTER	Record Counter

C.7.3 Power Plant Databases.

Table C-17. Power Plant metadata codes.

DATABASE FILE NAME (date of last updates = 02/28/92)	NUMBER OF RECORDS; DATABASE NAME
electric.dbf	1182; Electric Power Plants
nuclear.dbf	70; Nuclear Power Plants ("Reactors" Directory)

FIELD NAME	FIELD MEANING
FIPSSTATE	FIPS State Code
QUALIFIER	Direction Indicator (N, S, E, W)
FIPSCOUNTY	FIPS County Code
PLANTCODE	
UTILFILLER	
UTILCODE	(For DOE Internal Use)
SYSTEMTYPE	(For DOE Internal Use)
RECORDTYPE	(For DOE Internal Use)
BLAST	Code for Level of Damage; SEV = Severe, MOD = Moderate, LIT = Light, NON = None, Blank = None
YYMM	Currency of Data (YYMM)
LASTUPDATE	Date of Last Modification
USERID	User who Updated this Record
STATUS	(For DOE Internal Use)
TAG	Mark/Flag for Record
DAMTYPE	(For DOE Internal Use)
LBLAST	Blast Damage Indicator
LFIRE	Fire Damage Indicator
RADIATION	Radiation Damage Indicator
EARTHQUAKE	Earthquake Damage Indicator
HURRICANE	Hurricane Damage Indicator
FLOOD	Flood Damage Indicator
DROUGHT	Drought Damage Indicator
OTHER	Other Damage Indicator
PAD	Petroleum Administration for Defense (PAD) District; 1 = PAD District I - East Coast area, Appalachian #1 area 2 = PAD District II - Appalachian #2 area, Indiana-Illinois-Kentucky area, Minnesota-Wisconsin-North and South Dakota area, Oklahoma-Kansas-Missouri area 3 = PAD District III - Texas Inland area, Texas Gulf Coast area, Louisiana Gulf Coast area, North Louisiana-Arkansas area, New Mexico, 4 = PAD District IV - Rocky Mountains, 5 = PAD District V - West Coast
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)

FIELD NAME	FIELD MEANING
ZIPCODE	Zip Code
NERC	National Electric Reliability Council Area; ECAR = East Central Area Reliability Council, ERCT = Electric Reliability Council of Texas, MAAC = Mid-Atlantic Area Council, MAIN = Mid-Atlantic Interpool Network, MAPP = Mid-Continent Area Power Pool, NPCC = Northeast Power Coordinating Council, SERC = Southeastern Electric Reliability Council, SPP = Southwest Power Pool, WSCC = Western Systems Coordinating Council
STATEABBR	State Abbreviation
COUNTYNAME	County Name
FEMAREGION	FEMA Region Code
UTILNAME	Name of Utility
PLANTNAME	Facility Name
CITY	City Name
CONTACT	
PHONE	Telephone Number
TOTALCAP	Total Generating Capacity in Megawatts
COALCAP	Coal Capacity in Megawatts
OILCAP	Oil Capacity in Megawatts
GASCAP	Gas Capacity in Megawatts
NUCCAP	Nuclear Capacity in Megawatts
HYDROCAP	Hydro Capacity in Megawatts
TOTALGEN	Total Generation Capacity in Gigawatt Hours
PCTCOALGEN	Percent Generation Using Coal
PCTOILGEN	Percent Generation Using Oil
PCTGASGEN	Percent Generation Using Gas
PCTNUCGEN	Percent Generation Using Nuclear
PCTHYDROGN	Percent Generation Using Hydro
COALCONS	Coal Consumption in 1000 Short Tons
OILCONS	Oil Consumption in 1000 Barrels
GASCONS	Gas Consumption in 1000 MCF
COALSTOCK	Coal Stocks in 1000 Short Tons
OILSTOCK	Oil Stocks in 1000 Barrels
MINEMOUTH	Generating Plant Located Next to the Mine
COUNTER	Record Counter

C.7.4 Natural Gas Plants (ngpp.dbf).

Table C-18. Natural Gas Plants metadata codes.

Number of records	610
Date of last update	02/28/92

FIELD NAME	FIELD MEANING
FIPSSTATE	FIPS State Code
QUALIFIER	Direction Indicator (N, S, E, W)
FIPSCOUNTY	FIPS County Code
COMPANY ID	Unique ID Used Within EIA
SYSTEMTYPE	(For DOE Internal Use)

FIELD NAME	FIELD MEANING
RECORDTYPE	(For DOE Internal Use)
BLAST	Code for Level of Damage; SEV = Severe, MOD = Moderate, LIT = Light, NON = None, Blank = None
YYMM	Currency of Data (YYMM)
LASTUPDATE	Date of Last Modification
USERID	User who Updated this Record
STATUS	(For DOE Internal Use)
TAG	Mark/Flag for Record
DAMTYPE	(For DOE Internal Use)
LBLAST	Blast Damage Indicator
LFIRE	Fire Damage Indicator
RADIATION	Radiation Damage Indicator
EARTHQUAKE	Earthquake Damage Indicator
HURRICANE	Hurricane Damage Indicator
FLOOD	Flood Damage Indicator
DROUGHT	Drought Damage Indicator
OTHER	Other Damage Indicator
PAD	Petroleum Administration for Defense (PAD) District; 1 = PAD District I - East Coast area, Appalachian #1 area, 2 = PAD District II - Appalachian #2 area, Indiana-Illinois-Kentucky area, Minnesota-Wisconsin-North and South Dakota area, Oklahoma-Kansas-Missouri area 3 = PAD District III - Texas Inland area, Texas Gulf Coast area, Louisiana Gulf Coast area, North Louisiana-Arkansas area, New Mexico, 4 = PAD District IV - Rocky Mountains 5 = PAD District V - West Coast
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
ZIPCODE	Zip Code
NERC	National Electric Reliability Council Area; ECAR = East Central Area Reliability Council, ERCT = Electric Reliability Council of Texas, MAAC = Mid-Atlantic Area Council, MAIN = Mid-Atlantic Interpool Network, MAPP = Mid-Continent Area Power Pool, NPCC = Northeast Power Coordinating Council, SERC = Southeastern Electric Reliability Council, SPP = Southwest Power Pool, WSCC = Western Systems Coordinating Council
STATEABBR	State Abbreviation
COUNTYNAME	County Name
FEMAREGION	FEMA Region Code
COMPNAME	Company Name
PLANTNAME	Plant Name
CITY	City Name
CONTACT	
PHONE	Telephone Number
PLANT_TYPE	
CAPACITY	Production Capacity (MMcf/Day)
TOTALPROD	Total Production (1000 Barrels/Day)
ETHANE	Ethane Production (1000 Barrels/Day)
PROPANE	Propane Production (1000 Barrels/Day)
NORMBUTANE	Norbutane Production (1000 Barrels/Day)
ISOBUTANE	Isobutane Production (1000 Barrels/Day)
PNTANSPLUS	Pentanes Plus Production (1000 Barrels/Day)
ETHANESTK	Ethane Stocks (1000 Barrels/Day)

FIELD NAME	FIELD MEANING
PROPANESTK	Propane Stocks (1000 Barrels/Day)
NBUTNSTK	Normal Butane Stocks (1000 Barrels/Day)
IBUTNSTK	Isobutane Stocks (1000 Barrels/Day)
PNTNPLSSTK	Pentanes Plus Stocks (1000 Barrels/Day)
PIPELINE	Pipeline Transportation System
TRUCK	Truck Transportation System
BARGE	Barge Transportation System
TANKER	Tanker Transportation System
RAIL	Rail Transportation System
COUNTER	Record Counter

C.7.5 Natural Gas Storage (ngus.dbf).

Table C-19. Natural Gas Storage metadata codes.

Number of records	397
Date of last update	02/28/92

FIELD NAME	FIELD MEANING
FIPSSTATE	FIPS State Code
FIPSCOUNTY	FIPS County Code
COMPANYID	Unique ID Used within EIA
YYMM	Currency of Data (YYMM)
LASTUPDATE	Date of Last Modification
USERID	User who Updated this Record
STATUS	(For DOE Internal Use)
PAD	Petroleum Administration for Defense (PAD) District; 1 = PAD District I - East Coast area, Appalachian #1 area, 2 = PAD District II - Appalachian #2 area, Indiana-Illinois-Kentucky area, Minnesota-Wisconsin-North and South Dakota area, Oklahoma-Kansas-Missouri area 3 = PAD District III - Texas Inland area, Texas Gulf Coast area, Louisiana Gulf Coast area, North Louisiana-Arkansas area, New Mexico, 4 = PAD District IV - Rocky Mountains 5 = PAD District V - West Coast
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
ZIPCODE	Zip Code
STATEABBRV	State Abbreviation
COUNTYNAME	County Name
REGION	FEMA Region Code
COMPNAME	Company Name
FIELDNAME	Facility Name
RESERVOIR	
CAPACITY	Storage Capacity (Bcf)
ACCURACY	
COUNTER	Record Counter

C.7.6 Energy Import Facilities (petimprt.dbf).

Table C-20. Energy Import Facilities metadata codes.

Number of records	362
Date of last update	02/28/92

FIELD NAME	FIELD MEANING
FIPSSTATE	FIPS State Code
FIPSCOUNTY	FIPS County Code
YYMM	Currency of Data (YYMM)
LASTUPDATE	Date of Last Modification
STATUS	(For DOE Internal Use)
PAD	Petroleum Administration for Defense (PAD) District; 1 = PAD District I - East Coast area, Appalachian #1 area 2 = PAD District II - Appalachian #2 area, Indiana-Illinois-Kentucky area, Minnesota-Wisconsin-North and South Dakota area, Oklahoma-Kansas-Missouri area 3 = PAD District III - Texas Inland area, Texas Gulf Coast area, Louisiana Gulf Coast area, North Louisiana-Arkansas area, New Mexico 4 = PAD District IV - Rocky Mountains 5 = PAD District V - West Coast
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
ZIPCODE	Zip Code
STATEABBRV	State Abbreviation
COUNTYNAME	County Name
REGION	FEMA Region
AREA	One of 6 Army Area Codes
COMPNAME	Company Name
PLANTNAME	Facility Name
CITY	City
CONTACT	
PHONE	Telephone Number
STREET	Street Address
P_L_SUPPLY	
CAPACITY	Load/Offload Capacity (1000 Barrels)
COUNTER	Record Counter

C.7.7 Oil Refineries (refinery.dbf).

Table C-21. Oil Refineries metadata codes.

Number of records	192
Date of last update	02/28/92

FIELD NAME	FIELD MEANING
FIPSSTATE	FIPS State Code
QUALIFIER	Direction Indicator (N, S, E, W)
FIPSCOUNTY	FIPS County Code
COMPANY ID	Unique ID Used Within EIA
SYSTEMTYPE	(For DOE Internal Use)
RECORDTYPE	(For DOE Internal Use)

FIELD NAME	FIELD MEANING
BLAST	Code for Level of Damage; SEV = Severe, MOD = Moderate, LIT = Light, NON = None, Blank = None
YYMM	Currency of Data (YYMM)
LASTUPDATE	Date of Last Modification
USERID	User who Updated this Record
STATUS	(For DOE Internal Use)
TAG	Mark/Flag for Record
DAMTYPE	(For DOE Internal Use)
LBLAST	Blast Damage Indicator
LFIRE	Fire Damage Indicator
RADIATION	Radiation Damage Indicator
EARTHQUAKE	Earthquake Damage Indicator
HURRICANE	Hurricane Damage Indicator
FLOOD	Flood Damage Indicator
DROUGHT	Drought Damage Indicator
OTHER	Other Damage Indicator
PAD	Petroleum Administration for Defense (PAD) District; 1 = PAD District I - East Coast area, Appalachian #1 area 2 = PAD District II - Appalachian #2 area, Indiana-Illinois-Kentucky area, Minnesota-Wisconsin-North and South Dakota area, Oklahoma-Kansas-Missouri area 3 = PAD District III - Texas Inland area, Texas Gulf Coast area, Louisiana Gulf Coast area, North Louisiana-Arkansas area, New Mexico 4 = PAD District IV - Rocky Mountains 5 = PAD District V - West Coast
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
ZIPCODE	Zip Code
NERC	National Electric Reliability Council Area; ECAR = East Central Area Reliability Council, ERCT = Electric Reliability Council of Texas, MAAC = Mid-Atlantic Area Council, MAIN = Mid-Atlantic Interpool Network, MAPP = Mid-Continent Area Power Pool, NPCC = Northeast Power Coordinating Council, SERC = Southeastern Electric Reliability Council, SPP = Southwest Power Pool, WSCC = Western Systems Coordinating Council
STATEABBR	State Abbreviation
COUNTYNAME	County Name
FEMAREGION	FEMA Region Code
COMPNAME	Company Name
PLANTNAME	Facility Name
CITY	City Name
CONTACT	
PHONE	Telephone Number
CAPACITY	Refinery Capacity (1000 Barrels/Day)
GROSSINPT	Gross Input (1000 Barrels)
CRUDESTOK	Crude Stock (1000 Barrels)
TOTALPROD	Total Production (1000 Barrels/Day)
MOGAS	Mogas Production (1000 Barrels/Day)
AVGAS	Avgas Production (1000 Barrels/Day)
NAPTHAJET	Napthajet Production (1000 Barrels/Day)
KEROJET	Kerojet Production (1000 Barrels/Day)
KEROSENE	Kerosene Production (1000 Barrels/Day)

FIELD NAME	FIELD MEANING
DISTILLATE	Distillate Production (1000 Barrels/Day)
RESIDUAL	Residual Production (1000 Barrels/Day)
OTHERPROD	Other Production (1000 Barrels/Day)
MOGASSTK	Mogas Stocks (1000 Barrels)
AVGASSTK	Avgas Stocks (1000 Barrels)
NPTAJETSTK	Napthajet Stocks (1000 Barrels)
KEROJETSTK	Kerojet Stocks (1000 Barrels)
KEROSTK	Kerosene Stocks (1000 Barrels)
DISTSTK	Distillate Stocks (1000 Barrels)
RESIDSTK	Residual Stocks (1000 Barrels)
COUNTER	Record Counter

C.7.8 Strategic Reserve (spro.dbf).

Table C-22. Strategic Reserve metadata codes.

Number of records	7
Date of last update	02/28/92

FIELD NAME	FIELD MEANING
FIPSSTATE	FIPS State Code
QUALIFIER	Direction Modifier (N, S, E, W)
FIPSCOUNTY	FIPS County Code
COMPANYID	Unique ID Used Within EIA
SYSTEMTYPE	(For DOE Internal Use)
RECORDTYPE	(For DOE Internal Use)
BLAST	Level of Damage; SEV = Severe, MOD = Moderate, LIT = Light, NON = None, Space = None
YYMM	Currency of Data (YYMM)
LASTUPDATE	Date of Last Modification
USERID	User who Updated this Record
STATUS	(For DOE Internal Use)
TAG	Record Mark/Tag
DAMTYPE	(For DOE Internal Use)
LBLAST	Blast Damage Indicator
LFIRE	Fire Damage Indicator
RADIATION	Radiation Damage Indicator
EARTHQUAKE	Earthquake Damage Indicator
HURRICANE	Hurricane Damage Indicator
FLOOD	Flood Damage Indicator
DROUGHT	Drought Damage Indicator
OTHER	Other Damage Indicator
PAD	Petroleum Administration for Defense (PAD) District; 1 = PAD District I - East Coast area, Appalachian #1 area 2 = PAD District II - Appalachian #2 area, Indiana-Illinois-Kentucky area, Minnesota-Wisconsin-North and South Dakota area, Oklahoma-Kansas-Missouri area 3 = PAD District III - Texas Inland area, Texas Gulf Coast area, Louisiana Gulf Coast area, North Louisiana-Arkansas area, New Mexico 4 = PAD District IV - Rocky Mountains 5 = PAD District V - West Coast

FIELD NAME	FIELD MEANING
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
ZIPCODE	Zip Code
NERC	National Electric Reliability Council Area; ECAR = East Central Area Reliability Council, ERCT = Electric Reliability Council of Texas, MAAC = Mid-Atlantic Area Council, MAIN = Mid-Atlantic Interpool Network, MAPP = Mid-Continent Area Power Pool, NPCC = Northeast Power Coordinating Council, SERC = Southeastern Electric Reliability Council, SPP = Southwest Power Pool, WSCC = Western Systems Coordinating Council
STATEABBR	State Abbreviation
COUNTYNAME	County Name
FEMAREGION	FEMA Region Code
COMPNAME	Company Name
SITENAME	Facility Name
CITY	City Name
CONTACT	
PHONE	Telephone Number
STOCKS	Stocks (Barrels)
SWEET	Sweet Stocks (Barrels)
SOUR	Sour Stocks (Barrels)
DRAWDWNRT	Drawdown Rate (Barrels/Day)
COUNTER	Record Counter

C.7.9 Tank Farms (tankfarm.dbf).

Table C-23. Tank Farms metadata codes.

Number of records	1814
Date of last update	02/28/92

FIELD NAME	FIELD MEANING
FIPSSTATE	FIPS State Code
QUALIFIER	Direction Modifier (N, S, E, W)
FIPSCOUNTY	FIPS County Code
COMPANYID	Unique ID Used Within EIA
SYSTEMTYPE	(For DOE Internal Use)
RECORDTYPE	(For DOE Internal Use)
BLAST	Level of Damage; SEV = Severe, MOD = Moderate, LIT = Light, NON = None, Space = None
YYMM	Currency of Data (YYMM)
LASTUPDATE	Date of Last Modification
USERID	User who Updated this Record
STATUS	(For DOE Internal Use)
TAG	Record Mark/Flag
DAMTYPE	(For DOE Internal Use)
LBLAST	Blast Damage Indicator
LFIRE	Fire Damage Indicator
RADIATION	Radiation Damage Indicator
EARTHQUAKE	Earthquake Damage Indicator
HURRICANE	Hurricane Damage Indicator

FIELD NAME	FIELD MEANING
FLOOD	Flood Damage Indicator
DROUGHT	Drought Damage Indicator
OTHER	Other Damage Indicator
PAD	Petroleum Administration for Defense (PAD) District; 1 = PAD District I - East Coast area, Appalachian #1 area 2 = PAD District II - Appalachian #2 area, Indiana-Illinois-Kentucky area, Minnesota-Wisconsin-North and South Dakota area, Oklahoma-Kansas-Missouri area 3 = PAD District III - Texas Inland area, Texas Gulf Coast area, Louisiana Gulf Coast area, North Louisiana-Arkansas area, New Mexico 4 = PAD District IV - Rocky Mountains 5 = PAD District V - West Coast
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
ZIPCODE	Zip Code
NERC	National Electric Reliability Council Area; ECAR = East Central Area Reliability Council, ERCT = Electric Reliability Council of Texas, MAAC = Mid-Atlantic Area Council, MAIN = Mid-Atlantic Interpool Network, MAPP = Mid-Continent Area Power Pool, NPCC = Northeast Power Coordinating Council, SERC = Southeastern Electric Reliability Council, SPP = Southwest Power Pool, WSCC = Western Systems Coordinating Council
STATEABBR	State Abbreviation
COUNTYNAME	County Name
FEMAREGION	FEMA Region Code
COMPNAME	Company Name
PLANTNAME	Facility Name
CITY	City Name
CONTACT	
PHONE	Telephone Number
CAPACITY	Storage Capacity (Barrels)
P_L_SUPPLY	Interconnection
PIPELINEIN	Transportation System
TANKERIN	Transportation System
BARGEIN	Transportation System
TRUCKIN	Transportation System
RAILIN	Transportation System
TRUCKOUT	Transportation System
PIPELINOUT	Transportation System
TANKEROUT	Transportation System
BARGEOUT	Transportation System
RAILOUT	Transportation System
LEADMOTGAS	Type of Commodity
UNLEADGAS	Type of Commodity
DISFUELOIL	Type of Commodity
RESFUELOIL	Type of Commodity
KEROSENE	Type of Commodity
AVGAS	Type of Commodity
JETFUELS	Type of Commodity
ASPHALT	Type of Commodity
LUBEOILS	Type of Commodity
CRUDE	Type of Commodity

FIELD NAME	FIELD MEANING
OTHERPROD	Type of Commodity
LIQNATGAS	Type of Commodity
LIQPETGAS	Type of Commodity
PROPANE	Type of Commodity
COUNTER	Record Counter

C.8 "FACTORY" DIRECTORY.

C.8.1 Primary Factories (primarym.dbf).

Table C-24. Primary Factories metadata codes.

Number of records	1278
Date of last update	02/28/92

FIELD NAME	FIELD MEANING
CITY	City Name
STATEABBRV	State Abbreviation
ZIPCODE	Zip Code
COMPANY	Company Name
EMPLOYEES	Employment (Annual Average)
PRODUCTION	Production Capacity (Annual Average)
STORAGE	Storage Capacity (Annual Average)
PERCENTPR	Percent Production
PERCENTCA	Percent Capacity
REGION	FEMA Region
CITYCODE	FIPS City Code
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
MSACODE	Metropolitan Statistical Area Code
FIPSTATE	FIPS State Code
COUNTYCODE	FIPS County Code
SIC	Standard Industrial Classification Code
OPTYPE	Type of Operation Code; 01 = Mine, Underground, 02 = Mine, Open Pit, Quarry, 03 = Well, Dredge, 04 = Ore Beneficiation - Concentrating, etc., 05 = Smelting, 06 = Refining, Reduction, 07 = Sintering, Pelletizing (Taconite, Iron Ore), 08 = Evaporation-Exfoliation, 10 = Refining from Secondary Sources, 12 = Underground and Open Pit Mine, 14 = Underground Mine and Mill, 19 = Underground Mine and Calcining, 24 = Open Pit Mine and Crushing, 34 = Dredge and Concentrating, 38 = Well and Evaporation, 46 = Crushing and Reduction, 47 = Beneficiation and Agglomeration, 52 = Not Provided, 54 = Not Provided, 56 = Smelting and Refining, 66 = Alloying, 99 = Unknown
BOMNUMBER	Bureau of Mines Assigned Number
COUNTER	Record Counter
COMMODITY	Commodity Name
COMMODITYI	Commodity Code; No new information is provided here since codes refer to names in COMMODITY field.

C.9 GOVERNMENT "GOVERN" DIRECTORY.

C.9.1 Government Databases.

Table C-25. Government databases.

DATABASE FILE NAME (date of last updates = 02/28/92)	NUMBER OF RECORDS; DATABASE NAME
lawlegal.dbf	2828; LawLegal
atf.dbf	221; Bureau of Alcohol, Tobacco, and Firearms
attornys.dbf	351; Office of U.S. Attorneys ("Personel" Directory)
dea.dbf	172; Drug Enforcement Administration
justice.dbf.	30; Dept. of Justice
fbi.dbf	466; Federal Bureau of Investigation
ins.dbf	360; Immigration and Naturalization Service
prisons.dbf	56; Bureau of Prisons ("Prisons" Directory)
uscustms.dbf	523; U.S. Customs Service
usmarshl.dbf	374; U.S. Marshals Office
usecrets.dbf	142; U.S. Secret Service
coastgrd.dbf	133; Coast Guard ("Trans" Directory)

The following field names and meanings are common to all government databases.

Table C-26. Metadata codes common to all government databases.

FIELD NAME	FIELD MEANING
CITY	City Name
STATEABBRV	State Abbreviation
ZIPCODE	Zip Code
TOTALSPACE	Total Occupied Space (100 sq.ft.)
OFFICESPCE	Total Office Space (100 sq.ft.)
TOTALSTAFF	Total Personnel Occupying Space
OFFICESTAF	Total Personnel Occupying Office Space
REGION	FEMA Region Code
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
MSACODE	Metropolitan Statistical Area Code
COUNTYCODE	FIPS County Code
BUREAUCODE	Bureau Code to Identify Agency; 1500 = Department of Justice, 1513 = Federal Bureau of Investigation, 1515 = Immigration and Naturalization Service, 1519 = Bureau of Prisons, 1525 = U.S. Marshals Office, 1532 = Drug Enforcement Administration, 1535 = Office of U.S. Attorneys, 2005 = U.S. Customs Service, 2015 = Bureau of Alcohol, Tobacco, and Firearms, 2027 = U.S. Secret Service, 6903 = Coast Guard
COUNTER	Record Counter
NAME	Installation Name
ADDRESS	Installation Address

C.9.2 FEMA Regional Centers (femafrcs.dbf).

Table C-27. FEMA Regional Centers metadata codes.

Number of records	17
Date of last update	03/04/92
FIELD NAME	FIELD MEANING
CITY	City Name
STATEABBRV	State Abbreviation
ZIPCODE	Zip Code
REGION	FEMA Region Code
COUNTYCODE	FIPS County Code
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
SITENAME	Name and Address of Facility
COUNTER	Record Counter

C.9.3 RRS Mobility Sites (gsaallst.dbf).

Table C-28. RRS Mobility Sites metadata codes.

Number of records	21382
Date of last update	¾/92

FIELD NAME	FIELD MEANING
CITY	City Name
STATEABBRV	State Abbreviation
ZIPCODE	Zip Code
NAME	Agency Name and Location
ALLSPACE	Total Occupied Space, 100 sq.ft.
OFFSPACE	Total Office Space, 100 sq.ft.
ALLSTAFF	Total Personnel Occupying Space
OFFSTAFF	Personnel Occupying Office Space
REGION	FEMA Region Code
CITYCODE	FIPS City/Place Code
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
SMSACODE	Metropolitan Statistical Area Code
COUNTYCODE	FIPS County Code
GEOCODEA	GSA Region Code
CODE24	One of 388 Bureau-within-Agency Codes
COUNTER	Record Counter
AGENCYCODE	Agency Code (Digits 1-2 of CODE24 field)
AGENCYNAME	Agency Name
ADDRESS	Address of Agency
WAREHOUSE_	Total Occupied Space Minus Total Office Space, 100 sq.ft.
SYMSIZE	

C.9.4 Local Emergency Operation Centers (localeoc.dbf).

Table C-29. Local Emergency Operation Centers metadata codes.

Number of records	3171
Date of last update	03/04/92

FIELD NAME	FIELD MEANING
CITY	City Name
STATEABBRV	State Abbreviation
ZIPCODE	Zip Code
COUNTER	Record Counter
STRCT	Building Structure Code
EOCSPACESF	Usable Space in sq.ft.
STAFFENERG	Staff Required During Emergency
STAFFNORM	Staff Required Normally
PERSONSERV	Number of Persons Served
REGION	FEMA Region Code
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
MSACODE	Metropolitan Statistical Area Code
FIPST	FIPS State Code
COUNTYCODE	FIPS County Code
OPTYPE	
CODEA	Operational Generator Available; Y/N
CODEB	14-Day Fuel Supply for Emergency Generator; Y/N
CODEC	Sufficient Ventilation, Heating, A/C Connected to Generator; Y/N
CODED	Independent 14-Day Water Supply (without Outside Support); Y/N
CODEE	Adequate Sanitation Facilities; Y/N
CODEF	Adequate Medical Supplies Stored; Y/N
CODEG	14-Day Food Storage for Emerg. Staff; Y/N
CODEH	Sufficient Beds and Bed Spaces for One-Half Staff for 14-Days; Y/N
CODEI	Essential Maps, Charts, etc. Available; Y/N
CODEJ	EOC Used Daily by Local Agency; Y/N
CODEK	911 Circuit Availability; A = None, B = None at EOC, C = At EOC
CODEL	Electromagnetic (EMP) Protected; Y/N
CODE24 - digit 1	Communication Between EOC and Primary Operating Facility; Y/N
CODE24 - digit 2	Communication Between EOC and Other Emergency Forces; Y/N
CODE24 - digit 3	Communication Between EOC and Broadcast Media; Y/N
CODE24 - digit 4	Communication Between EOC and Next Higher Level EOC; Y/N
CODE24 - digit 5	Communication Between Local Jurisdiction and Adjacent Localities; Y/N
CODE24 - digit 6	Primary or Alternate Indicator; A = Primary EOC, B = Alternate EOC
CODE24 - digit 7	Ownership Distance from Headquarters; 1 = Principal Govt. Building, 2 = Public Bldg. within 1 mi. of Hdqtrs., 3 = Public Bldg. >1 mi. from Hdqtrs., 4 = Pvt. Bldg. within 1 mi. of Hdqtrs., 5 = Pvt. Bldg. > 1 mi. from Hdqtrs., 6 = Other Building Situation, 0 = Unknown
CODE24 - digit 8	(Space)
CODE24 - digit 9	Lowest or Below-Ground Space; 1 = Walls Fully Exposed or More Than Half Above Grade, 2 = Walls Half Exposed Above Grade, 3 = Walls Three-Fourths Below Grade, 4 = All Walls Fully Below Grade, 0 = Unknown
CODE24 - digit 10	(Space)

FIELD NAME	FIELD MEANING
CODE24 - digit 11	Level of Government Operation Code; 1 = Federal Government, 4 = County Government, 5 = County Equivalent Area Government, 6 = City or Village Government, 7 = Joint City/County Government, 0 = Other
CODE24 - digit 12	(Space)
CODE24 - digit 13-24	Level of Government Operation Narrative
NAMEEOC	Name of Emergency Operating Center
ADDRESS	Address of Emergency Operating Center

C.9.5 State Emergency Operation Centers (stateeoc.dbf).

Table C-30. State Emergency Operations Centers metadata codes.

Number of records	169
Date of last update	03/04/92

FIELD NAME	FIELD MEANING
CITY	City Name
STATEABBRV	State Abbreviation
ZIPCODE	Zip Code
COUNTER	Record Counter
STRCT	Building Structure Code
EOCSPACESF	Usable Protected Space in sq.ft.
STAFFENERG	Staff Required in an Emergency
STAFFNORM	Staff Assigned Normally
PERSONSERV	Population Served
REGION	FEMA Region Code
CITYCODE	FIPS City/Place Code
SMSACODE	Metropolitan Statistical Area Code
FIPST	FIPS State Code
COUNTYCODE	FIPS County Code
CODEA	Operational Generator Available; Y/N
CODEB	14-Day Fuel Supply for Emergency Generator; Y/N
CODEC	Operational Generator for Life Support; Y/N
CODED	Independent 14-Day Water Supply; Y/N
CODEE	Adequate Sanitation Facilities; Y/N
CODEF	Adequate Medical Supplies Stored; Y/N
CODEG	14-Day Food Supply for Emerg. Staff; Y/N
CODEH	Beds For One-Half Emergency Staff; Y/N
CODEI	Essential Maps, Charts, etc. Available; Y/N
CODEJ	EOC Used on Daily Basis; Y/N
CODEK	911 Circuit; A = None, X = Does Not Apply
CODEL	
CODE24 - digit 1	Radio Communication Between EOC and Primary Operating Facility; Y/N
CODE24 - digit 2	Radio Communication Between EOC and Other Radio; Y/N
CODE24 - digit 3	Radio Communication Between EOC and Broadcast Radio; Y/N
CODE24 - digit 4	Radio Communication Between EOC and Next Higher Level EOC; Y/N
CODE24 - digit 5	Radio Communication Between Local Jurisdiction and Adjacent Localities; Y/N
CODE24 - digit 6	Primary or Alternate Indicator; A = Primary EOC, B - R = Alternate EOC

FIELD NAME	FIELD MEANING
CODE24 - digit 7	Ownership Distance from Headquarters; 1 = Principal Govt. Building, 2 = Public Bldg. within 1 mi. of Hdqtrs., 3 = Public Bldg. >1 mi. from Hdqtrs., 4 = Pvt. Bldg. within 1 mi. of Hdqtrs., 5 = Pvt. Bldg. > 1 mi. from Hdqtrs., 6 = Other Building Situation, 0 = Unknown
CODE24 - digit 8	(Space)
CODE24 - digit 9	Lowest or Below-Ground Space; 1 = Walls Fully Exposed or More Than Half Above Grade, 2 = Walls Half Exposed Above Grade, 3 = Walls Three-Fourths Below Grade, 4 = All Walls Fully Below Grade, 0 = Unknown
CODE24 - digit 10	(Space)
CODE24 - digit 11	Level of Government Operation Code; 2 = State Government, 3 = State Area Equivalent, 8 = Joint State/County Government, 0 = Other
CODE24 - digit 12	(Space)
CODE24 - digit 13-24	Level of Government Operation Narrative
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
NAMEEOC	Name of Facility
ADDRESS	Address of Facility

C.10 "HOSPITALS" DIRECTORY.

C.10.1 Hospitals (hospital.dbf).

Table C-31. Hospitals metadata codes.

Number of Records	6,447

FIELD NAME	FIELD MEANING
ID	AHA Identification Number
REGION	U.S. Census Region Code
NAME	Name of Hospital
TITLE	Title of Hospital Administrator
ADMINSTR	Name of Hospital Administrator
ADDRESS	Street Address
CITY	City Name
STATE	State Code
STATEABBRV	State Postal Abbreviation
ZIPCODE	Zip Code
AREACODE	Telephone Area Code
TELEPHONE	Telephone Number
MSANAME	Metropolitan Statistical Area Name
MSMSANM	Metropolitan Statistical Area Code
ADULTDCR	Adult Day Care Program
ALCHIP	Alcohol/Chem Dependency Inpatient Unit
ALCHOP	Alcohol/Chem Dependency Outpatient Srvc.
ANGIO	Angioplasty
ARTHCEN	Arthritis Treatment Center
ASSTLIV	Assisted Living
BROOM	Birthing Room-LDR Room-LDRP Room
BCSMAN	Breast Cancer Screening/Mammograms

FIELD NAME	FIELD MEANING
BURNIC	Burn Care Unit
CCLAB	Cardiac Catherization Laboratory
CARDIC	Cardiac Intensive Care Unit
CMNGT	Case Management
CWPRGM	Children Wellness Program
QUALITY	Community Health Reporting
OTHPROV	Community Health Status Assessment
HSINDICA	Community Health Status Based Srvc. Planning
COMOUT	Community Outreach
CPRVT	Crisis Prevention
CTSCAN	CT Scanner
DENSERV	Dental Services
DRADISO	Diagnostic Radioisotope Facility
EMDEPT	Emergency Department
ESWL	Extracorporeal Shock Wave Lithotripter (ESWL)
FITCEN	Fitness Center
OPFREE	Freestanding Outpatient Care Center
GERSERV	Geriatric Services
TRNHLTH	Health Facility Transportation (to/from)
HLTHFR	Health Fair
HLTHCNT	Health Information Center
HLTHSCR	Health Screenings
AIDSSRV	HIV-AIDS Services
HOMHLTH	Home Health Services
HOSPICE	Hospice
OPHOSP	Hospital-Based Outpatient Care Center-Services
MRI	Magnetic Resonance Imaging (MRI)
MEALWHL	Meals on Wheels
MSIC	Medical Surgical Intensive Care Unit
NINT	Neonatal Intensive Care Unit
NUTPRGM	Nutrition Programs
OBIP	Obstetrics Unit
OCCHLTH	Occupational Health Services
ONCOLGY	Oncology Services
PATED	Patient Education Center
PATREP	Patient Representative Services
PEDIC	Pediatric Intensive Care Unit
REHABIP	Physical Rehabilitation Inpatient Unit
REHABOP	Physician Rehabilitation Outpatient Srvcs.
PET	Positron Emission Tomography Scanner (PET)
PCDEPT	Primary Care Department
PSYIP	Psychiatric Acute Inpatient Unit
PSYCHILD	Psychiatric Child Adolescent Services
PSYLAS	Psychiatric Consultation-Liason Services
PSYED	Psychiatric Education Services
PSYEM	Psychiatric Emergency Services
PSYGER	Psychiatric Geriatric Services
PSYOP	Psychiatric Outpatient Services
PSYPH	Psychiatric Partial Hospitalization Programs
RADTT	Radiation Therapy

FIELD NAME	FIELD MEANING
REPHLTH	Reproductive Health Services
RETHOU	Retirement Housing
SPECT	Single Photon Emiss. Comp. Tomography
SNU	Skilled Nursing or Other Long-Term-Care Unit
SOCWRK	Social Work Services
SPRTMD	Sports Medicine Clinic/Services
SUPGRPS	Support Groups
TOSERV	Teen Outreach Services
TRNSRV	Transplant Services
TRAUMA	Trauma Center (Certified)
ULTSND	Ultrasound
UCCNTR	Urgent Care Center
VOLSV	Volunteer Services Department
OHSURG	Open Heart Surgery
WOMCEN	Women's Health Center/Services
OPSURG	Outpatient Surgery
NOUNIT	Facilities and Services not Provided
HCSID	Health Care System Identification Number
CONTROL	Control Code
SERVICE	Service Code
COUNTY	Modified FIPS County Code
APPROVAL1	JCAHO Hospital Accreditation
APPROVAL2	Cancer Program American College of Surg.
APPROVAL3	Residency Approved by ACGME
APPROVAL4	Blank (not used)
APPROVAL5	Med. School Affil. Reported by AMA
APPROVAL6	Hospital-Controlled Prof. Nursing
APPROVAL7	Accreditation by CARF
APPROVAL8	Member of Council of Teaching Hospitals
APPROVAL9	Blue Cross Plan Contract or Participant
APPROVAL10	Medicare Program Certified Participant
APPROVAL11	Accredited by AOA
APPROVAL12	Internship Approved by AOA
APPROVAL13	Residency Approved by AOA
APPROVAL14	Registered Osteo. Hosp. (Member AOA)
APPROVAL15	Registered Osteo. Hosp. (Non-Mem. AOA)
PHYSCD1	Closed Physician-Hospital Org. (PHO)
PHYSCD2	Equity Model
PHYSCD3	Foundation
PHYSCD4	Group Practice Without Walls
PHYSCD5	Independent Practice Assn. (IPA)
PHYSCD6	Integrated Salary Model
PHYSCD7	Management Service Org. (MSO)
PHYSCD8	Open Physician-Hospital Org. (PHO)
CNTYNAME	Modified FIPS County Name
MEMBERTYPE	AHA Membership/Registration Type Code
TOTALBEDSN	Total Beds-Nursing Home
RESPONSE	AHA Annual Survey Response Code
TOTALBEDS	Total Beds
TOTALADMS	Total Admissions

FIELD NAME	FIELD MEANING
ADC	Average Daily Census
VTOT	Outpatient Visits
BIRTHS	Births
TOTALEXPN	Total Expenses
PAYROLLPUB	Published Payroll Expenses
FTE	Full Time Equivalents
SEPUNITS	Separate Units Code
HCSNAME	Health Care System Name
HCSCITY	Health Care System City
HCSSTAB	Health Care System State Abbreviation
COUNTER	Value is Constant = 1
LONDEGREES	Longitude in decimal degrees
LATDEGREES	Latitude in decimal degrees
MATCH_CODE	Code for Source of Coordinate
LOC_CODE	Code for Source of Coordinate
CARRT	Code for Source of Coordinate
DPBC	Code for Source of Coordinate
CHECK	Code for Source of Coordinate

C.10.2 VA Hospitals (vahosptl.dbf).

Table C-32. VA Hospitals metadata codes.

Number of records	155
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
CITY	City Name
STATE	State
ZIP	Zip Code
NAME_ADDR	VA Medical Center (VAMC) Name
FAC_NUMB	VAMC Facility Number
REGION	VA Region Number; 1 = CT, DC, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VA, VT, WV, 2 = IA, IL, IN, KS, KY, MI, MN, MO, ND, NE, OH, SD, WI, 3 = AL, AR, FL, GA, LA, MS, NC, OK, SC, TN, TX, 4 = AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
FCC	Federal Coordinating Center Flag
PRC	Primary Receiving Center Flag
SSC	Secondary Support Center Flag
ISC	Installation Support Center Flag
TOT_AOB	Total Hospital Average Operating Beds
TOT_SCI	Total Hospital Pct. Of Service Connected Inpatients
TOT_NH_AOB	Total VAMC Nursing Home Avg. Operating Beds
TOT_NH_SCI	Pct. of Svc. Connected Inpatients in Nursing Homes
TOT_DOM	Total Domiciliary Avg. Operating Beds
TOT_DOMSCI	Pct. of Svc. Connected Inpatients in Domiciliary
MM24	Medical Beds Available within 24 Hours

FIELD NAME	FIELD MEANING
MM72	Medical Beds Available within 72 Hours
MM_MAXBED	Maximum Number of Medical Beds Which Can be Made Available
MM_MAXDAY	Days Required to Achieve Maximum Medical Bed Availablility
MM_AOB	Average Operating Beds - Medical
MM_AOB_SCI	Pct. Of Service Connected Inpatients for Medical AOB
MP24	Psychiatry Beds Available within 24 Hours
MP72	Psychiatry Beds Available within 72 Hours
MP_MAXBED	Max. Beds Which Can be Made Available - Psychiatry
MP_MAXDAY	Days Required to Achieve Maximum Bed Availability - Psychiatry
MP_AOB	Average Operating Beds - Psychiatry
MP_AOB_SCI	Pct. of Service Connected Inpatients - Psychiatry AOB
SS24	Surgery Beds Available within 24 Hours
SS72	Surgery Beds Available within 72 Hours
SS_MAXBED	Max. Beds Which Can be Made Available - Surgery
SS_MAXDAY	Days Required to Achieve Maximum Bed Availability - Surgery
SS_AOB	Average Operating Beds - Surgery
SS_AOB_SCI	Pct. Of Service Connected Inpatients - Surgery AOB
SO24	Orthopedics Beds Available within 24 Hours
SO72	Orthopedics Beds Available within 72 Hours
SO_MAXBED	Maximum Beds Which Can be Made Available - Orthopedics
SO_MAXDAY	Days Required to Achieve Maximum Bed Availability - Orthopedics
SC24	Spinal Cord Injury Beds Available within 24 Hours
SC72	Spinal Cord Injury Beds Available within 72 Hours
SC_MAXBED	Maximum Beds Which Can be Made Available - Spinal Cord Injury
SC_MAXDAY	Days Required to Achieve Maximum Bed Availability - Spinal Cord Injury
SB24	Burn Beds Available within 24 Hours
SB72	Burn Beds Available within 72 Hours
SB_MAXBED	Maximum Beds Which Can be Made Available - Burn
SB_MAXDAY	Days Required to Achieve Maximum Bed Availability - Burn
SG24	Ob/Gyn Beds Available within 24 Hours
SG72	Ob/Gyn Beds Available within 72 Hours
SG_MAXBED	Maximum Beds Which Can be Made Available - Ob/Gyn
SG_MAXDAY	Days Required to Achieve Maximum Bed Availability - Ob/Gyn
COUNTER	Record Counter

C.11 "HOUSING" DIRECTORY.

C.11.1 1990 Housing by Zip Code (house90.dbf).

Table C-33. 1990 Housing by Zip Code metadata codes.

Number of records	29337
Date of last update	04/01/92

FIELD NAME	FIELD MEANING
STATEABBRV	State Abbreviation
STATENAME	State Name
COUNTYNAME	County Name
LONGITUDE	Longitude (decimal degrees)
LATITUDE	Latitude (decimal degrees)

ZIP	5-Digit Zip Code
PO_NAME	Post Office Name
MSACODE	Metropolitan Statistical Area Code
POP90	1990 Residential Population
HSGUNITS	Total Housing Units
TOTALOCC	Occupied Housing Units
TOTALVACNT	Vacant Housing Units
MEDVALUE	Median Value of Housing Units/Zip Area
COUNTER	Record Counter

C.11.2 Housing and Urban Development Field Offices (hudsites.dbf)

Number of records	85
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
CITY	City Name
STATEABBRV	State Abbreviation
ZIPCODE	Zip Code
EMPLOYEES	Number of Employees
REGION	FEMA Region Code
MSACODE	Metropolitan Statistical Area Code
COUNTYCODE	FIPS County Code
OFFICECODE	Type Office Code; A = Area Office, B = Service Office, C = Valuation and Endorsement Station, D = Single-Purpose Out-Station Office, HQ = Headquarters, RO = Regional Office, ROX = Regional Office Annex
ZIPCODE9	Zip Code
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
BUILDING	Building Name
ADDRESS	Building Address
OFFICENAME	Office Name
OFFICETYPE	Office Type
COUNTER	Record Counter

C.12 "LIVESTOCK" DIRECTORY.

C.12.1 Livestock Inventory (livestok.dbf).

Table C-34. Llivestock Inventory metadata codes.

Number of records	3057
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
CITY	City Name
STATEABBRV	State Abbreviation
ZIPCODE	Zip Code
MILKCOWS	Number of Milk Cows
CATLECALVS	Number of Cattle and Calves

HOGSPIGS	Number of Hogs and Pigs
SHEEPLAMBS	Number of Sheep and Lambs
HENPULLETS	Number of Hens and Pullets of Laying Age
BROILERS	Number of Broilers and Similar Chickens
TURKEYS	Number of Turkeys
REGION	FEMA Region Code
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
MSACODE	Metropolitan Statistical Area Code
COUNTYCODE	FIPS County Code
COUNTER	Record Counter

C.13 "PERSONEL" DIRECTORY.

C.13.1 U.S. Attorneys (attornys.dbf).

Please refer to "Government Databases" under the "GOVERNMENT" Directory.

C.13.2 Medical Personnel (medstaff.dbf).

Table C-35. Medical Personnel metadata codes.

Number of records	3074
Date of last update	12/17/91

FIELD NAME	FIELD MEANING
AGG_M_ST	State Abbreviation
AGG_M_CNTY	County Code
AGG_M_01	Total MD, NF
AGG_M_02	Total MD, GP, NF
AGG_M_03	Total MD, FP, NF
AGG_M_04	Total Gen. Srg., NF
AGG_M_05	Total Int. Med., NF
AGG_M_06	Total Nucl. Med., NF
AGG_M_07	Total Orth. Surg., NF
AGG_M_08	Total Ped., NF
AGG_M_09	Total Surg. Spec., NF
AGG_M_10	Total Ob/Gyn, NF
AGG_M_11	Total Anesth., NF
AGG_M_12	Total Emerg. Med., NF
AGG_M_13	Total Rad., NF
AGG_M_14	D.O. ACT, NF
AGG_M_15	Total ACT MD, NF
AGG_M_16	Total D.O. GP, NF
AGG_M_17	Total D.O. Int. Med., NF
AGG_M_18	Total D.O. Ped., NF
AGG_M_19	Total D.O. Ob/Gyn, NF
AGG_M_20	Total D.O. Gen. Surg., PC, OFBS, NF
AGG_M_21	D.O. Anesth., PC, OFBS, NF
AGG_M_22	D.O. Rad., PC, OFBS, NF
AGG_M_23	Total D.D.S. Act., NF

FIELD NAME	FIELD MEANING
AGG_M_24	Registered Nurses (RN's)
AGG_M_25	Licensed Practical Nurses (LPN's)
AGG_M_26	Total Nurse Practitioners
AGG_M_27	Nurse Practitioners/Midwives
AGG_M_28	Nurse Practitioners, Emergency
AGG_M_29	Total ACT Vets
AGG_M_30	Vets, Large Animal
AGG_M_31	Phys. Asst's
AGG_M_32	Clinical Lab Tech.
AGG_M_33	Medical Scientists
AGG_M_34	Estimated RN Total
AGG_M_35	Estimated RN Full Time
AGG_M_36	Estimated RN Part Time
AGG_M_37	Total MD Int. & Res., NF
AGG_M_38	MD GP, PC, HSP Res., NF
AGG_M_39	MD FP, PC Res., NF
AGG_M_40	Int. Med., PC Res., NF
AGG_M_41	Nuc. Med., PC Res., NF
AGG_M_42	Ped., PC Hsp. Res., NF
AGG_M_43	Surgical Spec., PC Res., NF
AGG_M_44	Gen. Srg., PC Res., NF
AGG_M_45	Ob/Gyn, PC Res., NF
AGG_M_46	Orth. Surg., PC Res., NF
AGG_M_47	Anesth., PC Res., NF
AGG_M_48	Emergency Med., PC Res., NF
AGG_M_49	Rad., PC Res., NF
AGG_M_50	Dentists Intrn/Res., GP & Ped.
AGG_M_51	Dentists Intrn/Res., Other
AGG_M_52	Medical Manpower Damage Percentage
MDRATIO	Ratio of DO's, DR's, DDS's per 1000 Pop.
RNRATIO	Ratio of RN's & LPN's per 1000 Pop.
LTRATIO	Ratio of CLT's per 1000 Pop.
STATEABBRV	FIPS State Abbreviation
STATENAME	State Name
COUNTYNAME	County Name
LONGITUDE	Longitude (decimal degrees)
LATITUDE	Latitude (decimal degrees)
COUNTER	Record Counter
MSACODE	Metropolitan Statistical Area Code
MSANAME	Metropolitan Statistical Area Name
REGION	FEMA Region Code

C.13.3 FEMA Personnel (personel.dbf).

Table C-36. FEMA Personnel metadata codes.

Number of records	1089
Date of last update	02/03/92

FIELD NAME	FIELD MEANING
PERSONNAME	Name of Person
ACTSTATUS	Actual Status Code; 0 = Unknown, 1 = No Damage, 2 = Moderate Damage, 3 = Severe Damage
PREDSTATUS	Predicted Status Code; 0 = Unknown, 1 = No Damage, 2 = Moderate Damage, 3 = Severe Damage
AGENCY	Abbreviated Agency Name
POSITION	Person's Level of Responsibility
STATDATTIM	Status Date and Time of Last Change
STATCHORGN	Status Change Indicator
SYSDATTIM	System Date and Time of Database Entry
EMTID	Emergency Management Team ID
IMA	Individual Mobilization Augmentee Flag
EPOC	Emergency Point-of-Contact
NDER	NDER Indicator; X = Member of NDER, Space = Not NDER Member
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
STATE	State Code
COUNTYCODE	County Code

C.13.4 VA Hospital Staff (vastaff.dbf).

Table C-37. VA Hospital Staff metadata codes.

Number of records	155
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
ZIP	Zip Code
STA_NUM	VA Facility Designator
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
FAC_NAME	VA Medical Center Name
CITY	City where Medical Center is Located
STATE	State Abbreviation
ZIPCODE	Zip Code
VA_REGION	VA Region
PHYS_TOT	Total Physicians On-Board
POB_18_45	Total Physicians On-Board, Ages 18-45
POB_46_59	Total Physicians On-Board, Ages 46-59
POB_60_UP	Total Physicians On-Board, Age 60 & Over
PRR_18_45	Physicians-Ready Reserve, Ages 18-45
PRR_46_59	Physicians-Ready Reserve, Ages 46-59
PRR_60_UP	Physicians-Ready Reserve, Age 60 & Over
PMR_18_45	Physicians-Military Retired, Ages 18-45
PMR_46_59	Physicians-Military Retired, Ages 46-59
PMR_60_UP	Physicians-Military Retired, Age 60 & Over
NURSES_TOT	Total Nurses On-Board

FIELD NAME	FIELD MEANING
NOB_18_45	Nurses On-Board, Ages 18-45
NOB_46_59	Nurses On-Board, Ages 46-59
NOB_60_UP	Nurses On-Board, Age 60 & Over
NRR_18_45	Nurses-Ready Reserve, Ages 18-45
NRR_46_59	Nurses-Ready Reserve, Ages 46-59
NRR_60_UP	Nurses-Ready Reserve, Age 60 & Over
NMR_18_45	Nurses-Military Retired, Ages 18-45
NMR_46_59	Nurses-Military Retired, Ages 46-59
NMR_60_UP	Nurses-Military Retired, Age 60 & Over
DENT_TOT	Total Dentists On-Board
DOB_18_45	Dentists On-Board, Ages 18-45
DOB_46_59	Dentists On-Board, Ages 46-59
DOB_60_UP	Dentists On-Board, Age 60 & Over
DRR_18_45	Dentists-Ready Reserve, Ages 18-45
DRR_46_59	Dentists-Ready Reserve, Ages 46-59
DRR_60_UP	Dentists-Ready Reserve, Age 60 & Over
DMR_18_45	Dentists-Military Retired, Ages 18-45
DMR_46_59	Dentists-Military Retired, Ages 46-59
DMR_60_UP	Dentists-Military Retired, Ages 60 & Over
OM_TOT	Total Other Medical Personnel On-Board
OMOB_18_45	Other Medical Personnel, Ages 18-45
OMOB_46_59	Other Medical Personnel, Ages 46-59
OMOB_60_UP	Other Medical Personnel, Age 60 & Over
OMRR_18_45	Other Medical-Ready Reserve, Ages 18-45
OMRR_46_59	Other Medical-Ready Reserve, Ages 46-59
OMRR_60_UP	Other Medical-Ready Reserve, Ages 60 & Over
OMMR_18_45	Other Medical-Military Retired, Ages 18-45
OMMR_46_59	Other Medical-Military Retired, Ages 46-59
OMMR_60_UP	Other Medical-Military Retired, Ages 60 & Over
SUPP_TOT	Total Support Staff On-Board
SOB_18_45	Support Staff On-Board, Ages 18-45
SOB_46_59	Support Staff On-Board, Ages 46-59
SOB_60_UP	Support Staff On-Board, Age 60 & Over
SRR_18_45	Support Staff-Ready Reserve, Ages 18-45
SRR_46_59	Support Staff-Ready Reserve, Ages 46-59
SRR_60_UP	Support Staff-Ready Reserve, Ages 60 & Over
SMR_18_45	Support Staff-Military Retired, Ages 18-45
SMR_46_59	Support Staff-Military Retired, Ages 46-59
SMR_60_UP	Support Staff-Military Retired, Age 60 & Over
TOT_STAFF	Total On-Board at Medical Center
TOT_OB_18	Total On-Board, Ages 18-45
TOT_OB_46	Total On-Board, Ages 46-59
TOT_OB_60	Total On-Board, Age 60 & Over
TOT_RR_18	Total In Ready Reserve, Ages 18-45
TOT_RR_46	Total In Ready Reserve, Ages 46-59
TOT_RR_60	Total In Ready Reserve, Age 60 & Over
TOT_MR_18	Total Military Retired, Ages 18-45
TOT_MR_46	Total Military Retired, Ages 46-59
TOT_MR_60	Total Military Retired, Age 60 & Over
COUNTER	Record Counter

C.14 U.S. POST OFFICE "POSTAL" DIRECTORY.

C.14.1 Major Postal Sites (uspsmpf.dbf).

Table C-38. Major Postal Sites metadata codes.

Number of records	548
Date of last update	03/05/92

FIELD NAME	FIELD MEANING
STATEABBRV	State Abbreviation
CITY	City Name
UNIT	Description
ZIPCODE	Zip Code
ADDRESS	Address of Facility
COUNTYNAME	County Name
REGIONUSPS	Postal Region Code; 1 = Northeast Region, 2 = Eastern Region, 3 = Southern Region, 4 = Central Region, 5 = Western Region
DISTRICT	Postal District within Postal Region (first digit refers to Postal Region from REGIONUSPS field); 1A = New York City, 1E = Boston, 1F = Portland, 1J = Connecticut Valley, 1K = Northern New England, 1L = Caribbean, 1M = Long Island, 1N = Northern New Jersey, 1Q = Westchester, 2B = Delaware Valley, 2C = Maryland-DC, 2D = Maryland-DC, 2F = Allegheny, 2L = Delaware Valley, 2M = Mountaineer, 2P = Susquehanna, 2U = Virginia, 3A = East Texas, 3D = Atlanta, 3E = East Texas, 3Q = Delta, 3R = Mid-South, 3S = Mid-South, 3T = Oklahoma, 3U = West Texas, 3W = Florida, 4A = Northern Illinois, 4B = Michigan, 4D = Chicago P.O., 4G = Indiana, 4H = Mid-America, 4J = Gtr. Wisconsin, 4K = Gateway, 4M = Iowa, 4P = Dakotas, 5A = Alaska, 5B = Angeles, 5C = Golden Gate, 5D = Northwest, 5E = Pacific, 5F = Rocky Mountain, 5G = Sequoia
DISTRICT (Cont.)	(additional definitions for same field); 5H = Sierra, 5K = Sunland, 5L = Western Slopes, 5M = Sequoia
FPCODE	Primary Function Code; A = USPS Headquarters, B = Classified Branch, C = Sectional Center, D = District Office, E = BMC and AUX Facility, I = Air Mail Facility, L = Parcel Post Annex, M = Main Office, N = Carrier Annex, O = Other, P = Mail Prod. Annex, Q = PDC or ADPC, R = Regional Headquarters/Office, S = Classified Station, U = Area Supply Center, X = Trans. Management Office, Y = Inspection Service Region HQ, Z = Inspection Service Div. HQ, Space = Not Provided
FSCODE	Secondary Function Code; A = USPS Headquarters, C = Sectional Center, D = District Office, E = BMC and AUX Facility, I = Air Mail Facility, J = Air Transfer Office, L = Parcel Post Annex, M = Main Office, N = Carrier Annex, P = Mail Prod. Annex, Q = PDC or ADPC, S = Classified Station, X = Inspection Service Region HQ, Z = Inspection Service Div. HQ, Space = Not Provided
FTCODE	Tertiary Function Code; B = Classified Branch, C = Sectional Center, D = District Office, E = BMC and AUX Facility, I = Air Mail Facility, L = Parcel Post Annex, M = Main Office, N = Carrier Annex, O = Other, P = Mail Prod. Annex, R = Regional Headquarters/Office, S = Classified Station, U = Area Supply Center, X = Trans. Management Office, Y = Inspection Service Region HQ, Z = Inspection Service Div. HQ, Space = Not Provided

FIELD NAME	FIELD MEANING
ADMIN	Facility Administrator Code; 1 = USPS, 2 = GSA, 3 = Leased, Space = Not Provided
MECHDD	Mechanization Code; A = No Letter/Sack/Parcel Sort Machines, B = 5 or More MPLSMS, C = 4 or Less MPLSMS, D = 1 or More SPLSMS, E = Parcel and/or Sack Sort, F = Not Provided, Space = Unknown
FUELCD	Fuel Type Code; A = Gasoline, B = Diesel, Space = Unknown
TANKCD	Tank Location Code; A = Above Ground, B = Buried, Space = Unknown
RRSIDE	Postal Facility RR Siding
PKMNSF	Postal Vehicle Parking
CONTROL	USPS Identification Number
STFAC	Site Structural Description Code
STUSE	Site Structural Description Code
FRAME	Site Structural Description Code
STORYN	Site Structural Description Code
STRNCD	Site Structural Description Code
FIDECD	Site Structural Description Code
FRAMING	Site Structural Description Code
EMPLOYEES	Number of Employees
INTOSF	Floor Space in sq.ft.
DELIVERIES	Number of Deliveries
CITYVH	Number of City Delivery Vehicles
CARGOVH	Number of Cargo Vehicles
TRACTOR	Number of Tractors
TRAILER	Number of Trailers
DOCKS	Number of Docks
FUXNO5	
GALLON	Fuel Storage Capacity, in Gallons
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
COUNTER	Record Counter

C.14.2 U.S. Postal Vehicle Maintenance (uspsvmf.dbf).

Table C-39. Postal Vehicle Maintenance metadata codes.

Number of records	293
Date of last update	03/05/92

FIELD NAME	FIELD MEANING
STATEABBRV	State Abbreviation
CITY	City Name
UNIT	Description of Type Vehicle Maintenance Facility
ZIPCODE	Zip Code
ADDRESS	Address of Facility
COUNTYNAME	County Name
REGIONUSPS	Postal Region Code; 1 = Northeast Region, 2 = Eastern Region, 3 = Southern Region, 4 = Central Region, 5 = Western Region

FIELD NAME	FIELD MEANING
DISTRICT	Postal District within Postal Region (first digit refers to Postal Region from REGIONUSPS field); 1A = New York City, 1E = Boston, 1F = Portland, 1J = Connecticut Valley, 1K = Northern New England, 1L = Caribbean, 1M = Long Island, 1N = Northern New Jersey, 1Q = Westchester, 2B = Delaware Valley, 2C = Maryland-DC, 2D = Maryland-DC, 2F = Allegheny, 2L = Delaware Valley, 2M = Mountaineer, 2P = Susquehanna, 2U = Virginia, 3A = East Texas, 3D = Atlanta, 3E = East Texas, 3Q = Delta, 3R = Mid-South, 3S = Mid-South, 3T = Oklahoma, 3U = West Texas, 3W = Florida, 4A = Northern Illinois, 4B = Michigan, 4D = Chicago P.O., 4G = Indiana, 4H = Mid-America, 4J = Gtr. Wisconsin, 4K = Gateway, 4M = Iowa, 4P = Dakotas, 5A = Alaska, 5B = Angeles, 5C = Golden Gate, 5D = Northwest, 5E = Pacific, 5F = Rocky Mountain, 5G = Sequoia
DISTRICT (Cont.)	(additional definitions for same field); 5H = Sierra, 5K = Sunland, 5L = Western Slopes, 5M = Sequoia
FPCODE	Primary Function Code; Space = USPS Headquarters, B = Classified Branch, C = Sectional Center, D = District Office, E = BMC and AUX Facility, M = Main Office, P = Mail Prod. Annex, S = Classified Station,
FSCODE	Secondary Function Code; Space = USPS Headquarters, C = Sectional Center, D = District Office, E = BMC and AUX Facility, M = Main Office, N = Carrier Annex, P = Mail Prod. Annex, S = Classified Station, U = Area Supply Center
FTCODE	Tertiary Function Code; Space = USPS Headquarters, C = Sectional Center, D = District Office, E = BMC and AUX Facility, I = Air Mail Facility, L = Parcel Post Annex, M = Main Office, N = Carrier Annex, P = Mail Prod. Annex, S = Classified Station, U = Area Supply Center, X = Trans. Management Office
ADMIN	Facility Administrator Code; 1 = USPS, 2 = GSA, 3 = Leased
MECHDD	Mechanization Code; A = No Letter/Sack/Parcel Sort Machines, B = 5 or More MPLSMS, C = 4 or Less MPLSMS, D = 1 or More SPLSMS, E = Parcel and/or Sack Sort, Space = Not Provided
VFUELCD	Vehicle Fuel Type Code; A = Gasoline, B = Diesel, Space = Unknown
VTANKCD	Vehicle Tank Location Code; B = Buried, Space = Unknown
RRSIDE	Postal Facility RR Siding; Y/N
PKMNSF	Postal Vehicle Parking; Y/N
CONTROL	USPS Identification Number
STFAC	Site Structural Description Code
STUSE	Site Structural Description Code
VFRAME	Site Structural Description Code
VSTORYN	Site Structural Description Code
VSTRNCD	Site Structural Description Code
VFIDECD	Site Structural Description Code
VFRAMING	Site Structural Description Code
EMPLOYEES	Number of Employees
ISFVMF	Floor Space in sq.ft.
VTOWTRK	Number of Tow Trucks
VSVCVH	Number of Service Vehicles
VBAYS	Number of Service Bays
VGALLON	Fuel Storage Capacity in Gallons
BLANKS	
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
COUNTER	Record Counter

C.15 "PRISONS" DIRECTORY.

C.15.1 Prisons (prisons.dbf).

Please refer to "Government Databases" under the "GOVERNMENT" Directory.

C.16 RAILROAD "RAIL" DIRECTORY.

C.16.1 Operating RR Abbreviations (ALPHACDE Field Meanings).

AMTK = Amtrak
ATSF = Atchison, Topeka, & Santa Fe
BN = Burlington Northern
BO = Baltimore & Ohio
CN = Grand Trunk (ME & NH)
CNW = Chicago & Northwestern
CO = Chesapeake & Ohio
CPR = Canadian Pacific
CR = Conrail
ICG = Illinois Central Gulf
LI = Long Island
LN = Louisville-Nashville
MILW = Milwaukee
MP = Missouri Pacific
NW = Norfolk & Western
PLE = Pittsburg-Lake Erie
RFP = Richmond-Fredericksburg-Potomac
RI = Rock Island
SCL = Seaboard Coast Line
SOU = Southern Railway Company
SP = Southern Pacific
UP = Union Pacific
WM = Western Maryland Railway
ALS = Alton & Southern RR Co.
BAR = Bangor & Aroostook RR Co.
BLE = Bessemer & Lake Erie RR Co.
BM = Boston & Maine Corporation
BRC = Belt Railway Company of Chicago
CCO = Clinchfield RR Co.
CIM = Chicago & Illinois Midland Rail
CS = Colorado & Southern Rwy Co.
CSS = Chicago So.Shore/South Bend RR
CV = Central Vermont Railway
DH = Delaware & Hudson Rwy Co.
GTW = Grand Trunk Western RR Co.
KCS = Kansas City Southern Rwy Co.
LT = Lake Terminal RR Co.
MKT = Missouri-Kansas-Texas RR Co.
PI = Paducah & Illinois RR Co.
SI = Spokane International RR
SLSF = St. Louis-San Fransisco Railway
SSW = St. Louis Southwestern Rwy Co.
TM = Texas Mexican Railway Co.
TRRA = Terminal RR Assoc. of St. Louis
TT = Toledo Terminal Railroad
AC, BCOL, LA, QC, QNSL = Unknown

C.16.2 Railroad Databases.

Table C-40. Railroad Databases.

DATABASE FILE NAME (date of last updates = 03/02/92)	NUMBER OF RECORDS; DATABASE NAME
rrcoamtk.dbf	32; Amtrak
rrcoatsf.dbf	63; Atchison, Topeka, and Santa Fe
rrcobn.dbf	64; Burlington Northern
rrcobo.dbf	106; Baltimore and Ohio
rrcocn.dbf	222; Grand Trunk (ME and NH)
rrcocnw.dbf	34; Chicago and Northwestern
rrcoco.dbf	53; Chesapeake and Ohio
rrcocpr.dbf	127; Canadian Pacific
rrcocrr.dbf	86; Conrail
rrcoig.dbf	40; Illinois Central Gulf
rrcoli.dbf	94; Long Island
rrcoln.dbf	60; Louisville-Nashville

DATABASE FILE NAME (date of last updates = 03/02/92)	NUMBER OF RECORDS; DATABASE NAME
rrcomilw.dbf	39; Milwaukee
rrcomp.dbf	49; Missouri Pacific
rrconw.dbf	97; Norfolk and Western
rrcople.dbf	15; Pittsburgh-Lake Erie
rrcorfp.dbf	14; Richmond-Fredericksburg-Potomac
rrcori.dbf	37; Rock Island
rrcoscl.dbf	84; Seaboard Coast Line
rrcosou.dbf	146; Southern Railway Company
rrcosp.dbf	333; Southern Pacific
rrcoup.dbf	104; Union Pacific
rrcompny.dbf	2228; All Rail Sites
rrcomisc.dbf	329; Miscellaneous Companies

The following field names and meanings are common to all railroad databases.

Table C-41. Metadata common to all railroad databases.

FIELD NAME	FIELD MEANING
ALPHACDE	Operating RR Abbreviation; see above
STATEABBRV	State Abbreviation
OETRG	OET Region Code
AARCODE	AAR-Assigned Identification Code
ROUTFROM	Origin of RR Route
ROUTEVIA	RR Route Passes Through
ROUTETO	Destination of RR Route
FRACODE	FRA-Assigned Code
FACNAME	Name of Facility
MILEPOST	Milepost Label and Distance
CITY	Nearest City or Town
COUNTYNAME	County Name
COUNTRY	Country Code; US = United States, CA = Canada
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
TYPEFAC	Type of Facility; intface = Interface, rrbridge = Railroad Bridge, rrtunnel = Railroad Tunnel, rryard = Railroad Yard
COUNTER	Record Counter

C.16.3 Railroad Bridges (rrbridge.dbf).

Table C-42. Railroad Bridges metadata codes.

Number of records	1641
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
ALPHACDE	Operating RR Abbreviation; see above
STATEABBRV	State Abbreviation
ROUTFROM	Origin of RR Route
ROUTEVIA	RR Route Passes Through

FIELD NAME	FIELD MEANING
ROUTETO	Destination of RR Route
FACNAME	RR Bridge Name
MILEPOST	Milepost Label and Distance
CITY	Nearest City or Town
COUNTYNAME	County Name
COUNTRY	Country Code; US = United States, CA = Canada
AZIMUTH	
CREADATE	Date Added to File (MMYY)
LENGTH	Length of Bridge in Feet
TRACKS	Number of Tracks Abreast
TRKCLASS	FRA Track Class (U.S. only)
PLATEC	Accommodate Plate 'C' Car; Y/N
PASSLAD	Pass 263K Lb. Car/Lading; Y/N
MAINSPAN	Number of Main Spans
LONGSPAN	Length of Longest Span
SPANTYPE	Type of Span; 1 = Through Truss, 2 = Deck Truss, 3 = Through Girder, 4 = Deck Girder, 5 = Orthotropic Plate Girder, 6 = Beam or Stringer, 7 = Arch, 8 = Trestle, 9 = Causeway or Fill, 0 = Other
SPANMATL	Type of Span Material; 1 = Steel, 2 = Concrete, 3 = Reinforced Concrete, 4 = Prestressed Concrete, 5 = Masonry, 6 = Timber, 7 = Wrought Iron, 8 = Causeway or Fill, 9 = Other
PIERMATL	Type of Bridge Pier Material; 1 = Concrete, 2 = Masonry, 3 = Steel, 4 = Piles, 5 = Other
FIXMOVE	Fixed/Moveable Bridge Code; 1 = Fixed, 2 = Swing, 3 = Bascule/Rolling Lift, 4 = Vertical Lift, 5 = Other
MAXVERCL	Maximum Vertical Underclearance
MAXHORCL	Maximum Horizontal Underclearance
OPSYEAR	Daily Freight Data Received
DFREIGHT	Freight Trains Daily
DPASSENG	Passenger Trains Daily
GROSSTON	Gross Tons/Year Over Bridge
OREPLACE	Replacement Time (Bridge Out); 1 = Under 1 Week, 2 = 1 to 3 Weeks, 3 = 1 to 2 Months, 4 = 3 to 5 Months, 5 = 6 to 11 Months, 6 = 1 Year or More, 0 = Unknown
MREPLACE	Main Span Replacement Time; see above codes for OREPLACE field
ALTROUTE	Alternate Route Crossing
COMMENTS	Additional Information
XTRAFLD	
UPDATE	Date Received by OET (YYMM)
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
OVERONE	Primary Terrain Bridged; 1 = Water-Navigable, 2 = Water-Non-Navigable, 3 = Marshlands-Flood Plain, 4 = Dry Wash, 5 = Highway, 6 = Other Railroad, 7 = Canyon or Valley, 8 = Other, 0 = -
OVERTWO	Second Terrain Bridged; see above codes for OVERONE field
OVERTHREE	Third Terrain Bridged; see above codes for OVERONE field
OETREGION	OET Region Code
AARCODES	
COUNTER	Record Counter

C.16.4 Railroad Computers (rrcmputr.dbf).

Table C-43. Railroad Computers metadata codes.

Number of records	27
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
ALPHACDE	Operating RR Abbreviation; see above
STATEABBRV	State Abbreviation
RECTYPE	
OETRG	OET Region
AARCODE	AAR-Assigned Identification Code
ROUTFRM	Origin of RR Route
ROUTEVIA	RR Route Passes Through
ROUTETO	Destination of RR Route
FRACODE	FRA Code
OTHERAIL	Other RR Using Facility
FACNAME	Name of Facility
MILEPOST	Milepost Label and Distance
CITY	Nearest City or Town
COUNTYNAME	County Name
COUNTRY	Country Code; US = United States, CA =Canada
AZIMUTH	
CREADATE	Date Added to File (MMYY)
MATERIAL	Building Construction Materials; 1 = Steel Frame, 2 = Reinforced Concrete Frame, 3 = Concrete Slab, 4 = Masonry, 5 = Wood Frame, 6 = Other, 0 = Unknown
STORIES	Number of Stories
MODEL	Computer Model
COMPTYPE	Type Computer Code; 1 = Central Facility; 2 = Satellite Facility, 0 = Unknown
OPDATE	Year Ops. Data Received
OFFUNCTN	Main Office Function; 1 = Corporate Headquarters, 2 = District/Division/General Office, 3 = Computer Facility, 0 = Unknown
USES	Main Uses of Computer; 1 = Operations, 2 = Accounting, 3 = Other, 0 = Unknown
EFFECT	Effect on System; 1 = Extremely Severe, 2 = Severe, 3 = Moderate, 4 = Slight, 0 = Unknown
ALTPLANS	Alternate Plans
CONVMAN	Conversion to Manual; 1 = Less than 1 Week, 2 = 1 to 3 Weeks, 3 = 1 to 2 Months, 4 = 3 to 5 Months, 5 = 6 to 11 Months, 6 = 1 Year or More
COMMENTS	Additional Information
XTRA	
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
COUNTER	Record Counter

C.16.5 Railroad Controls (rrcntrol.dbf).

Table C-44. Railroad Controls metadata codes.

Number of records	168
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
ALPHACDE	Operating RR Abbreviation; see above
STATEABBRV	State Abbreviation
RECTYPE	
OETRG	OET Region Code
AARCODE	AAR-Assigned Identification Code
ROUTFROM	Origin of RR Route
ROUTEVIA	RR Route Passes Through
ROUTETO	Destination of RR Route
FRACODE	FRA Code
OTHERAIL	Other RR Using Facility
FACNAME	Name of Facility
MILEPOST	Milepost Label and Distance
CITY	Nearest City or Town
COUNTYNAME	County Name
COUNTRY	Country Code; US = United States, CA = Canada
AZIMUTH	
CREADATE	Date Added to File (MMYY)
VULNERBL	
OPSYEAR	Year OPS Data Obtained
MATERIAL	Building Construction Material; 1 = Steel Frame, 2 = Reinforced Concrete Frame, 3 = Concrete Slab, 4 = Masonry, 5 = Wood Frame, 6 = Other, 0 = Unknown
STORIES	Number of Stories
DESCR	CTC Equipment Description
RDMILES	Road Miles Governed by CTC
TRKMILES	Track Miles Governed by CTC
RTDESCR	Route Description
EFFECT	Effect on System; 1 = Extremely Severe, 2 = Severe, 3 = Moderate, 4 = Slight, 0 = Unknown
REPLACE	Replacement Time for CTC; 1 = under 1 week, 2 = 1 to 3 weeks, 3 = 1 to 2 months, 4 = 3 to 5 months, 5 = 6 to 11 months, 6 = 1 year or more
ALTPLANS	Alternate Plans
COMMENTS	Additional Information
XTRA	
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
COUNTER	Record Counter

C.16.6 Railroad Interfaces (rrintfac.dbf).

Table C-45. Railroad Interfaces metadata codes.

Number of records	75
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
ALPHACDE	Operating RR Abbreviation; see above
STATEABBRV	State Abbreviation
CATNO	
OETRG	OET Region
AARCODE	AAR-Assigned Identification Code
ROUTFRM	Origin of RR Route
VIA	RR Route Passes Through
ROUTETO	Destination of RR Route
FRACODE	FRA Code
OTHERAIL	Other RR Using Facility
FACNAME	Name of Facility
MILEPOST	Milepost Label and Distance
CITY	Nearest City or Town
COUNTYNAME	County Name
COUNTRY	Country Code; US = United States, CA =Canada
ANGLE	
CREADATE	Date Added to File (MMYY)
CLASSIF	
VULNERBL	
PHYSFEAT	Physical Features
OPDATE	Year Ops. Data Received
OPERATNS	Operational Features
EFFECT	Effect on System; 1 = Extremely Severe, 2 = Severe, 3 = Moderate, 4 = Slight, 0 = Unknown
ALTPLAN	Alternate Interface Plan
COMMENTS	Additional Information
ENDREC	
DAY1	
DAY2	
DAY3	
DAY4	
DAY5	
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
TYPEFAC	Type of Facility; intface = Interface
COUNTER	Record Counter

C.16.7 Railroad Interlockings (rrintloc.dbf).

Table C-46. Railroad Interlockings metadata codes.

Number of records	42
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
ALPHACDE	Operating RR Abbreviation; see above
STATEABBRV	State Abbreviation
OETRG	OET Region
AARCODE	AAR-Assigned Identification Code
ROUTFRM	Origin of RR Route
ROUTEVIA	RR Route Passes Through
ROUTETO	Destination of RR Route
FRACODE	FRA Code
OTHERAIL	Other RR Using Facility
FACNAME	Name of Facility
MILEPOST	Milepost Label and Distance
CITY	Nearest City or Town
COUNTYNAME	County Name
COUNTRY	Country Code; US = United States, CA =Canada
AZIMUTH	
CREADATE	Date Added to File (MMYY)
VULNERBL	
CONEW	
FEATURES	Physical Features
OPDATE	Year Ops. Info Obtained
TRAINS	Number of Trains Daily
SIGFACTS	Significant Facts
EFFECT	Effect on System; 0 = Unknown, 1 = Extremely Severe, 2 = Severe, 3 = Moderate, 4 = Slight
TRKREPAV	Track Replacement Available; Y/N
REPLACE	Track Replacement Time; 1 = Under 1 Week, 2 = 1 to 3 Weeks, 3 = 1 to 2 Months, 4 = 3 to 5 Months, 5 = 6 to 11 Months, 6 = 1 Year or More, 0 = Unknown
CONMREPL	Control Mach. Replace. Time; 1 = Under 1 Week, 2 = 1 to 3 Weeks, 3 = 1 to 2 Months, 4 = 3 to 5 Months, 5 = 6 to 11 Months, 6 = 1 Year or More, 0 = Unknown
COMMENTS	Additional Information
XTRA	
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
COUNTER	Record Counter

C.16.8 Railroad Miscellaneous Sites (rrmiscel.dbf).

Table C-47. Railroad Miscellaneous Sites metadata codes.

Number of records	93
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
ALPHACDE	Operating RR Abbreviation; see above
STATEABBRV	State Abbreviation
RECTYPE	
OETRG	OET Region Code
AARCODE	AAR-Assigned Identification Code
ROUTFROM	Origin of RR Route
ROUTEVIA	RR Route Passes Through
ROUTETO	Destination of RR Route
FRACODE	FRA Code
OTHERAIL	Other RR Using Facility
FACNAME	Name of Facility
MILEPOST	Milepost Label and Distance
CITY	Nearest City or Town
COUNTYNAME	County Name
COUNTRY	Country Code; US = United States, CA = Canada
AZIMUTH	
CREADATE	Date Added to File (MMYY)
SECCLASS	
VULNERBL	
BLDGMATL	Building Construction Material Code; 1 = Steel Frame, 2 = Reinforced Concrete Frame, 3 = Concrete Slab, 4 = Masonry, 5 = Wood Frame, 6 = Other, 0 = Unknown
STORIES	Number of Stories
FACTS	Significant Features
OPSYEAR	Year OPS Data Obtained
FUNCTNS	Major Facility Functions
EFFECT	Effect on System; 1 = Extremely Severe, 2 = Severe, 3 = Moderate, 4 = Slight, 0 = Unknown
ALTPLANS	Alternate Plans
COMMENTS	Additional Information
XTRA	
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
COUNTER	Record Counter

C.16.9 Railroad Repair Shops (rrshops.dbf).

Table C-48. Railroad Repair Shops metadata codes.

Number of records	237
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
ALPHACDE	Operating RR Abbreviation; see above
STATEABBRV	State Abbreviation
OETRG	OET Region
AARCODE	AAR-Assigned Identification Code
ROUTFRM	Origin of RR Route
VIA	RR Route Passes Through
ROUTETO	Destination of RR Route
FRACODE	FRA Code
OTHERAIL	Other RR Using Facility
FACNAME	Name of Facility
MILEPOST	Milepost Label and Distance
CITY	Nearest City or Town
COUNTYNAME	County Name
COUNTRY	Country Code; US = United States, CA =Canada
AZIMUTH	
CREADATE	Date Added to File (MMYY)
CLASSIF	
VULNERBL	
LENGTH	Length of Shop in Feet
WIDTH	Width of Shop in Feet
AREA	Area of Shop in Acres
NUMBLDG	Total Number of Shop Buildings
NUMCRANE	Total Number of Cranes in Shop
TYPECRANE	Crane Type; 0 = 0, 1 = No Cranes, 2 = Bridge or Gantry, 3 = Boom-Fixed, 4 = Boom-Mobile-Rubber Tire, 5 = Boom-Mobile-Rail Mounted, 6 = Drop Table, 7 = Other
CRANECAP	Largest Capacity of Crane; 0 = 0, 1 = No Cranes, 2 = Small (10-25 Tons), 3 = Medium (50 Ton), 4 = Large (100 Ton), 5 = Extra Large (250 Ton), 6 = Other
FUELCAP	Fueling Facility Capacity
OPDATE	Year Ops. Information Obtained
NEWLOCO	New Locomotives Built Per Year; 1 = None, 2 = 1 - 50, 3 = 51 - 100, 4 = 101 - 250, 5 = 251 - 500, 6 = 501 - 999, 7 = 1000 or More, 0 = 0
REPLOCO	Locomotives Repaired Per Year; see above codes for NEWLOCO field
MAINTLOC	Locomotives Maintained Per Year; see above codes for NEWLOCO field
NEWFRCAR	New Freight Cars Built Per Year; see above codes for NEWLOCO field
REPFRCAR	Freight Cars Repaired Per Year; see above codes for NEWLOCO field
MAINTFRC	Freight Cars Maintained Per Year; see above codes for NEWLOCO field
NEWPASCR	New Passenger Cars Built Per Year; see above codes for NEWLOCO field
REPASCAR	Passenger Cars Repaired Per Year; see above codes for NEWLOCO field
MAINTPAS	Passenger Cars Maintained Per Year; see above codes for NEWLOCO field
NUMEMPLY	Number of Shop Employees
ALTSHOP	Alternate Shops in Emergency
COMMENTS	Additional Information

FIELD NAME	FIELD MEANING
ENDREC	
DAY1	
DAY2	
DAY3	
DAY4	
DAY5	
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
COUNTYCODE	FIPS County Code
COUNTER	Record Counter

C.16.10 Railroad Tunnels (rrtunnel.dbf).

Table C-49. Railroad Tunnels metadata codes.

Number of records	359
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
ALPHACDE	Operating RR Abbreviation; see above
STATEABBRV	State Abbreviation
OETRG	OET Region
AARCODE	AAR-Assigned Identification Code
ROUTFRM	Origin of RR Route
ROUTVIA	RR Route Passes Through
ROUTTO	Destination of RR Route
FRACODE	FRA Code
OTHERAIL	Other RR Using Facility
FACNAME	Name of Facility
MILEPOST	Milepost Label and Distance
CITY	Nearest City or Town
COUNTYNAME	County Name
COUNTRY	Country Code; US = United States, CA =Canada
AZIMUTH	
CREADATE	Date Added to File (MMYY)
VULNERBL	
LENGTH	Length of Tunnel in Feet
UNDER1	Terrain Tunneled Under (1); 1 = Water, 2 = Mountain or Hill, 3 = Urbanization, 4 = Other, 0 = Unknown
UNDER2	Terrain Tunneled Under (2); 1 = Water, 2 = Mountain or Hill, 3 = Urbanization, 4 = Other, 0 = Unknown
UNDER3	Terrain Tunneled Under (3); 1 = Water, 2 = Mountain or Hill, 3 = Urbanization, 4 = Other, 0 = Unknown
TRACKS	Number of Tracks in Tunnel
TRKCLASS	FRA Track Class
PLATEC	Accommodate Class 'C' Car; Y/N
LINING	Tunnel Lining Code; 1 = Rock, 2 = Concrete, 3 = Masonry, 4 = Iron or Steel, 5 = Timber, 6 = Other, 0 = Unknown
OPSYEAR	Year Ops. Data Obtained
FREIGHTR	Freight Trains Daily

FIELD NAME	FIELD MEANING
PASSENTR	Passenger Trains Daily
GROSSTON	Gross Tons/Yr., in Millions
REOPEN	Time to Reopen in Emergency; 0 = Unknown, 1 = Less Than 1 Week, 2 = 1 to 3 Weeks, 3 = 1 to 2 Months, 4 = 3 to 5 Months, 5 = 6 to 11 Months, 6 = 1 Year or More
ALTROUTE	Alternate Route
COMMENTS	Additional Information
XTRA	
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
LATEND	Latitude - End (DDMMSS)
LONGEND	Longitude - End (DDDMMSS)
TYPEFAC	Type of Facility; rrtunnel = Railroad Tunnel
COUNTER	Record Counter

C.16.11 Railroad Yards (rryards.dbf).

Table C-50. Railroad Yards metadata codes.

Number of records	422
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
ALPHACDE	Operating RR Abbreviation; see above
STATEABBRV	State Abbreviation
CATNO	
OETRG	OET Region Code
AARCODE	AAR-Assigned Identification Code
ROUTEFRM	Origin of RR Route
VIA	RR Route Passes Through
ROUTETO	Destination of RR Route
FRACODE	FRA Code
OTHERAIL	Other RR Using Yard
FACNAME	Name of Rail Yard
MILEPOST	Milepost Label and Distance
CITY	Nearest City or Town
COUNTYNAME	County Name
COUNTRY	Country Code; US = United States, CA =Canada
ANGLE	Azimuth
CREADATE	Date Added to File (MMYY)
YARDTYPE	Type of Rail Yard; 1 = Fully Automatic, 2 = Semi-Automatic, 3 = Manual
NUMHUMP	Number of Humps in Yard
NUMRETRD	Number of Retarders in Yard
RETARD1	Retarder Type - Pair 1
RETARD2	Retarder Type - Pair 2
FACLNGTH	Yard Length, 10 Ft. Units
FACWIDTH	Yard Width, 10 Ft. Units
NUMCLTRK	Number of Classification Tracks
YRDSTOR	Yard Storage Capacity, 50 Ft. Cars
NUMRECTK	Number of Receiving Tracks

FIELD NAME	FIELD MEANING
TRKCAP	Storage Capacity of Receiving Tracks
FUELGAL	Fueling Capacity, Gallons
OPDATE	Year Ops. Data Received
DAILYCAP	Yard Throughput, in Cars
MAXCRDLY	Max. Daily Classification Cars in Yard
AVRDAYCA	Avg. Daily Classification Cars
MAXCARYD	Max. Number of Cars in Yard
AVRYDCAR	Avg. Number of Cars in Yard
MAXLOCYD	Max. Number of Locomotives in Yard
AVRYDLOC	Avg. Number of Locomotives in Yard
MAXENGYD	Max. Daily Engine Tricks
AVRYDENG	Avg. Daily Engine Tricks
COMPUTER	Yard Depends on Computers; Y/N
INTERFCE	Related to an Interface; Y/N
EFFECT	Effect on System; 1 = Extremely Severe, 2 = Severe, 3 = Moderate, 4 = Slight, 0 = Unknown
ALTFAC1	Alternate Yards to Use
MILINST1	Military Bases Served
COMMENTS	Additional Information
ENDREC	
DAY1	
DAY2	
DAY3	
DAY4	
DAY5	
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
TYPEFAC	Type Facility; rryard = Railroad Yard
COUNTER	Record Counter

C.17 NUCLEAR "REACTORS" DIRECTORY.

C.17.1 Nuclear Power Plants (nuclear.dbf).

Please refer to "Power Plant Databases" under the "ENERGY" Directory.

C.18 TRANSPORTATION "TRANS" DIRECTORY.

C.18.1 Coast Guard (coastgrd.dbf).

Please refer to "Government Databases" under the "GOVERNMENT" Directory.

C.18.2 Interstate Structures (ihnation.dbf).

Table C-51. Interstate Structures metadata codes.

Number of records	62640
Date of last update	01/21/92

FIELD NAME	FIELD MEANING
CITY	City Name
STATEABBRV	State Abbreviation
NAME	Location Descriptor
STRUCTURE	DOT-Assigned Structure Code
BRIDGELNTH	Length of Bridge in Feet
DAILYTRFIC	Average Daily Traffic
DETOURLNTH	Detour Length in Miles
REGION	FEMA Region Code
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
COUNTYCODE	FIPS County Code
OPTYPE - digit 1	Type of Service On Bridge; 1 = Highway, 2 = Railroad, 3 = Pedestrian Exclusively, 4 = Highway-Railroad, 5 = Highway-Pedestrian, 6 = Overpass Structure at an Interchange (or 2nd Level of a Multilevel Exchange), 7 = Third Level (Interchange), 8 = Fourth Level (Interchange), 9 = Building or Plaza, 0 = Other, Space = Not Provided
OPTYPE - digit 2	Type of Service Under Bridge; 1 = Highway With/Without Pedestrian, 2 = Railroad, 3 = Pedestrian Exclusively, 4 = Highway-Railroad, 5 = Waterway, 6 = Highway-Waterway, 7 = Railroad-Waterway, 8 = Highway-Waterway-Railroad, 9 = Relief, 0 = Other, Space = Not Provided
CODEA	
CODEB	
INTERSTATE	2-Digit Interstate Number
COUNTER	Record Counter
MAINROUTE	3-Digit Interstate Number

C.18.3 Deep Water Locks and Dams (locksdam.dbf).

Table C-52. Deep Water Locks and Dams metadata codes.

Number of records	24
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
CITY	Nearest City or Town
COUNTYNAME	County Name
STATEABBRV	State Abbreviation
STRNAME	Structure Name
SMSA	Metropolitan Statistical Area Name
STATENAME	State Name
SMSACODE	Metropolitan Statistical Area Code
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
COUNTYCODE	FIPS County Code
REGIONCODE	FEMA Region Code
COUNTER	Record Counter

C.18.4 Inland Waterways Locks and Dams (locksriv.dbf).

Table C-53. Inland Waterways Locks and Dams metadata codes.

Number of records	328
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
CITY	Nearest City or Town
COUNTYNAME	County Name
SMSANAME	Metropolitan Statistical Area Name
STATEABBRV	State Abbreviation
NAME	Name of Facility
NAVLOCKS	Number of Navigational Locks
DAMSTR	Dam Structure Codes; RE = Earth, ER = Rockfill, PG = Gravity, DB = Buttress, VA = Arch, OT = Other, MV = Multi-Arch
REGION	OET Region, 1-11
HEIGHT	Height
OPTYPE	Type of Facility; C = Flood Control, D = Debris Control, H = Hydroelectric, I = Irrigation, N = Navigation, O = Other, P = Stock or Small Farm Pond, R = Recreation, S = Water Supply
UNIQUEID	Facility ID Code
OWNERSHP	Ownership Code; N = Non-Federal, G = Federal Government, C = Corps of Engineers
FEDREG	Federally Regulated; Y/N
PRIVATE	Private Dam on Federal Land; Y/N
UNSAFE	Unsafe Dam Code; Y/N
HAZARD	Downstream Hazard Potential; 1 = High, 2 = Medium, 3 = Low
SPILLAGE	Dam Spillage Control Code; C = Controlled, U = Uncontrolled, N = None
SECAFFIL	Secondary Affiliation
STATENAME	State Name
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
COUNTYCODE	FIPS County Code
COUNTER	Record Counter
OWNERNAME	Name of Owner
RIVERNAME	Name of River

C.18.5 Air Navigational Aids (navaids.dbf).

Table C-54. Air Navigational Aids metadata codes.

Number of records	3110
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
CITY	Nearest City or Town
STATEABBRV	State Abbreviation
COUNTYNAME	County Name
REGION	OET Region, 1-11
ZIP1	Zip Code
ADDR1	First Address Line

FIELD NAME	FIELD MEANING
OPTYPE	
GEOCODEA	Navigational Aid ID Codes; C = Vortac (Omni Tacan Range), D = VOR/DMS or Blank, R = NDB (Radio Beacon), T = Tacan (Tact. Air Navig.), V = VOR (Omnirange), O = Radar Installation
FREQ	Nav. Aid Frequency (Mhz)
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
COUNTER	Record Counter

C.18.6 Ports – Inland Waterways and Terminals (portsriv.dbf).

Table C-55. Ports-Inland Waterways and Terminals metadata codes.

Number of records	1598
Date of last update	03/02/92

FIELD NAME	FIELD MEANING
CITY	City Name
STATEABBRV	State Abbreviation
ZIPCODE	Zip Code
PIERLENGTH	Length of Pier in Feet
VESSELS	Number of Vessels that can Berth Simultaneously
CARGOSQFT	General Cargo Storage (sq.ft. or 1K sq.ft.?)
CARGOACRES	General Cargo Storage in Acres
DRYBULKACS	Dry Bulk Storage in Acres
DRYBULKOUT	Dry Bulk Storage Outside (1000 LT)
DRYBULKIN	Dry Bulk Storage Inside (1000 LT)
LIQUIDTANK	Number of Liquid Bulk Tanks
LIQUIDCAP	Liquid Bulk Capacity (1000 BBLs)
GRAINBULK	Bulk Grain Storage Capacity (1000 BU)
REGION	
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
COUNTYCODE	FIPS County Code
PIERTYPE	Pier Structure Type; A = Wharf-Marginal, B = Wharf-Wood Bulkhead, C = Wharf-Bulkhead not Wood, D = Wharf-Offshore, E = Wharf-Pontoon, F = Wharf-Other, G = Pier-Finger, H = Pier-T-Head, I = Pier-L-Head, J = Pier-Irregular Shape, K = Dolphins w/Float. Plat., L = Pier-Other, M = Single Point Mooring, N = Other, O = Submarine Pipeline, P = Cells, R = Pilings and Cells, S = Pilings, T = Cluster Pilings, U = Dolphins, V = Barge, Z = Natural Bark
OWNERCODE	Type of Ownership; A = U.S. Government, B = Public, C = Private, D = Pre-Alloc. DOD
PIERACESS	Pier Access Code; B = Rail, Truck, C = Rail, Pipeline, D = Truck, Pipeline, E = Rail, Truck, Pipe, F = Conveyor, Truck, G = Conveyor, Rail, H = Conveyor, Pipe, J = Convey, RR, Pipe, K = Convey, RR, Truck, L = Convey, Hwy, Pipe, M = Hwy, RR, Pipe, CNV, P = Pipeline, R = Rail, S = Conveyor, T = Truck
PIERACCES1	Pier Access to Side 1; see above codes for PIERACESS field
PIERACCES2	Pier Access to Side 2; see above codes for PIERACESS field
CARGOACCES	General Cargo Storage Access; see above codes for PIERACESS field

FIELD NAME	FIELD MEANING
DRYBULKACC	Dry Bulk Storage Access; see above codes for PIERACESS field
WETBULKACC	Wet Bulk Storage Access; see above codes for PIERACESS field
GRAINACCES	Grain Storage Access; see above codes for PIERACESS field
RIVERBANKL	
REGIONOET	OET Region Code (1-11)
CODE24	
NAME	City and State
COMPANY	Name of Company
ADDRESS	Address of Company
COUNTER	Record Counter

C.18.7 Ports – East and West Coast.

Table C-56. Ports-East and West Coast metadata codes.

Number of records	portwest.dbf: 1009; porteast.dbf: 1169
Date of last update	portwest.dbf: 03/02/92; porteast.dbf: 03/04/92

FIELD NAME	FIELD MEANING
PORTNAME	Port City and State
TERMNAME	Terminal Name
TERMADDR	Terminal Address
CITY	Terminal City
STATE	Terminal State
PORTCODE	Census Port Code
COASTREG	Coastal Region; 00 = Inland River System, 01 = North Atlantic, 02 = South Atlantic, 03 = Gulf Coast, 04 = South Pacific, 05 = North Pacific, 06 = Great Lakes, 07 = Hawaii, 08 = Alaska, 09 = Puerto Rico/Virgin Islands
ASOFDATE	Date of Lastest Update (YYMMDD)
OWNERNAM	Owner Name
OWNERADR	Owner Address
OWNERCTY	Owner City
OWNERST	Owner State
OWNCLASS	Owner's Classification; A = U.S. Government, B = Public, C = Private
OPER1	Operator Name and Address
TERMUSE	Terminal Use, which can be comprised of combinations of the following codes: A = General Cargo, B = Container, C = Lash/Seabee, D = RO/RO, E = Dry Bulk, F = Liquid Bulk, G = LNG, H = LPG, I = LOG, J = Bulk Grain, K = Repair Facility, L = Automobile, M = Passenger, N = Ferry, P = Other, Q = Fleeting Area, R = Fishing, S = Offshore Service, T = Mooring Berth, U = Inactive
AGENCY	Pre-Allocation Agency
TERMCOND	Terminal Condition Code; A = Good, B = Fair, C = Poor, D = Under Construction, E = Destroyed
DEPTH	Channel Depth in Feet

FIELD NAME	FIELD MEANING
RIVER (portwest.dbf)	River Name (abbreviated); BY = Brazos (New River), BZ = Brazos River (TX), CA = Calcasieu River & Pass, CE = Chento River (OR), CH = Chan. to Aransas Pass (TX), CM = Columbia River (OR), CP = Channel to Palacios (TX), CQ = Coquille River (OR), DC = Dow Barge Canal, GI = GIWW, HS = Houston Ship Canal, IH = Inner Harbor Nav. Canal, MJ = Lower Mississippi River, ML = ML, NR = Neches River, NS = Neches River Channel, SA = Sabine River & Harbor, SB = San Bernard River (TX), SJ = San Jacinto River (TX), SN = Sabine-Maches Waterway, SW = Siuslaw River (OR), TC = Texas City Channel, UM = Umpqua River (OR), WR = Willamette River, YQ = Yaquina River (OR)
RIVER (porteast.dbf)	River Name (abbreviated); CF = Chicago River (South Br.), CJ = Christina River, CK = Chicago River, CN = Chicago River (North Br.), CT = Calumet River (IL), CY = Cuyahoga River (OH), DE = Delaware River (DE), DR = Detroit River, GC = Gulf Coast, JR = James River (VA), LC = Lake Calumet (IL), LE = Lake Erie, LH = Lake Huron, LM = Lake Michigan, LO = Lake Ontario, LS = Lake Superior, MS = Mobile Ship Canal, RR = Rouge River (MI), SL = Saint Lawrence River, SU = Schuylkill River
RIVMILE	River Mile in Tenths
MOORTYP1	Type of Mooring - Area 1; A = Anchor, B = Bank, C = Other, D = Dolphin, P = Pilings
PIERNAME	Pier Name
VESSTYPE	Vessel Types (up to 5); A = Tanker, B = General Cargo, C = Container, D = RO/RO, E = Lash/Seabee, F = OBO (Ore, Bulk, Oil), G = Passenger, H = Pass./Freighter, I = Dry Bulk, J = LNG/LPG, K = Spec. Liq. Chem. Carrier, L = Refridgerated, M = Other, N = Barges, O = Self-Unloading Barges, P = Not in Use, Q = Tug/Barge Mooring, R = Mooring, S = Vessel Repairs, T = Self-Unloading, U = Crew Boat, V = Offshore Supply, W = Car Carrier, X = Fishing, Z = Ferry
LGVESDWT	Max. Vessel (in 1000's DWT)
CARGO	Cargo Types (up to 5); 1 = Wood Chips, 2 = Fish, 3 = Logs, 4 = Cement, 5 = Asphalt, 6 = Fuel Oil-Plant Use, 7 = Dry Bulk Misc., 8 = Liquid Bulk Misc., A = General Cargo, B = Pass./Gen. Cargo, C = Passenger, D = Wood Products, E = Coal/Coke Products, F = Ores Concentrates, G = Non-Metallic Min., H = Iron, Steel, Mill Prod., I = Fertilizers, J = Crude Petroleum, K = Refined Petrol. Prod., L = LNG, M = LPG, N = Liquid Bulk Ores, O = Grain, P = Bulk Raw Sugar, Q = Bauxite/Aluminum Ores, R = Liquid Chemicals, S = Other, T = Molasses, U = Caustic Soda, V = Scrap Metal, W = Refridgerated, Z = Automobiles
PIERSTR	Pier Structure Type; A = Wharf-Marginal, B = Wharf-Wood Bulkhead, C = Wharf-Bulkhead not Wood, D = Wharf-Offshore, E = Wharf-Pontoon, F = Wharf-Other, G = Pier-Finger, H = Pier-T-Head, I = Pier-L-Head, J = Pier-Irregular Shape, K = Dolphins w/Float. Plat., L = Pier-Other, M = Single Point Mooring, N = Other, O = Submarine Pipeline, P = Cells, R = Pilings and Cells, S = Pilings, T = Cluster Pilings, U = Dolphins, V = Barge, Z = Natural Bark
PIERMAT	Pier Construction Materials; A = Aluminum, B = Corrugated Aluminum, C = Asbestos, D = Pre-cast Concrete, E = Concrete, F = Steel, G = Corrugated Steel, H = Metals-Other, I = Wood or Timber, J = Brick or Cinderblock, K = Asphalt, L = Fill, M = Steel Frame, N = Wooden Frame, O = Metal Frame-Other, P = Concrete Frame, Q = Reinforced Concrete, R = Other, S = Steel Piling, T = Timber Piling, U = Concrete Piling

FIELD NAME	FIELD MEANING
APRONMAT	Apron Construction Material; see codes above for PIERMAT field
PIERLEN	Total Pier Length
LENGTHFE	Pier Length - Face/End
LENGTHS1	Pier Length - Side 1
LENGTHS2	Pier Length - Side 2
DEPTHFE	Minimum Depth - Face/End
DEPTHS1	Minimum Depth - Side 1
DEPTHS2	Minimum Depth - Side 2
VESBERFE	Vessels Berthed - Face/End
VESBERS1	Vessels Berthed - Side 1
VESBERS2	Vessels Berthed - Side 2
VESLENFE	Vessel Length - Face/End
DECKHFE	Deck Height - Face/End
DECKHS1	Deck Height - Side 1
DECKHS2	Deck Height - Side 2
APRONFE	Deck and Apron Width - Face/End
APRONS1	Deck and Apron Width - Side 1
APRONS2	Deck and Apron Width - Side 2
LOADFE	Load Cap. (lb/sq.ft.) - Face/End
LOADS1	Load Cap. (lb/sq.ft.) - Side 1
LOADS2	Load Cap. (lb/sq.ft.) - Side 2
ACCFE	Pier Access to Face/End; B = Rail, Truck, C = Rail, Pipeline, D = Truck, Pipeline, E = Rail, Truck, Pipe, F = Conveyor, Truck, G = Conveyor, Rail, H = Conveyor, Pipe, J = Convey, RR, Pipe, K = Convey, RR, Truck, L = Convey, Hwy, Pipe, M = Hwy, RR, Pipe, CNV, P = Pipeline, R = Rail, S = Conveyor, T = Truck
ACCS1	Pier Access to Side 1; see codes above for ACCFE field
ACCS2	Pier Access to Side 2; see codes above for ACCFE field
FPCONTRL	Federal Port Control (Y/N)
BRTHL1FE	Berth Length 1 - Face/End
BRTHL1S1	Berth Length 1 - Side 1
BRTHL1S2	Berth Length 1 - Side 2
GCSTOR1	General Cargo Storage - Area 1
GCSTOR2	General Cargo Storage - Area 2
GCSTOR3	General Cargo Storage - Area 3
GCACRE1	General Cargo Tot. Stor. Acres - Area 1
GCACRE2	General Cargo Tot. Stor. Acres - Area 2
GCACRE3	General Cargo Tot. Stor. Acres - Area 3
GCACCESS	General Cargo Storage Access; see codes above for ACCFE field
GCEQUIP1	General Cargo Equipment Type 1; 1 = Yard Tractor, 2 = Auger, 3 = Whipline, 4 = Ships Gear, 5 = Stevedore Furnished, 6 = Mobile Crane, 7 = Crawler Crane, 8 = Gantry Crane, 9 = Loading, A = General Cargo Crane, B = Container Crane, C = Straddle Carrier, D = Sidelift, E = Fork Lift with Spreader, F = Transtainer, G = Yard Crane-Other, H = Shiploader, I = Gantry Unload with Bucket, J = Pneumatic Loader, K = Pneumatic Unloader, L = Marine Leg, M = Gravity Chute Load Spout, N = Other, O = Hulet, P = Locomotive Crane, Q = Front-End Loader, R = Lumber Carrier, S = Crane with Magnet, T = Clam Shell Bucket, U = Bridge Crane, V = Bulldozer, W = Conveyor Belt System, X = Fork Lifts, Y = Shoreside RO/RO Ramp, Z = Reclaimer
GCEQUIP2	General Cargo Equipment Type 2; see codes above for GCEQUIP1 field

FIELD NAME	FIELD MEANING
GCEQUIP3	General Cargo Equipment Type 3; see codes above for GCEQUIP1 field
GCEQUPC1	Gen. Cargo # of Equipment Pieces, Group 1
GCEQUPC2	Gen. Cargo # of Equipment Pieces, Group 2
GCEQUPC3	Gen. Cargo # of Equipment Pieces, Group 3
EQLCAP1	Gen. Cargo Equipment Lift Capacity, Group 1
EQLCAP2	Gen. Cargo Equipment Lift Capacity, Group 2
EQLCAP3	Gen. Cargo Equipment Lift Capacity, Group 3
EQLCAP4	Gen. Cargo Equipment Lift Capacity, Group 4
EQHRATE1	Gen. Cargo Equipment Handling Rate, Group 1
EQHRATE2	Gen. Cargo Equipment Handling Rate, Group 2
EQHRATE3	Gen. Cargo Equipment Handling Rate, Group 3
CONTHCAP	Container Capacity (20' Equiv.)
CONSTKHT	Container Stacking Height; 1 = 1 High, 2 = 2 High, 3 = 3 High, 4 = 4 High, 5 = 5 High, C = On Chassis
DBACRE1	Dry Bulk Storage in Acres, Area 1
DBACRE2	Dry Bulk Storage in Acres, Area 2
DBOPEN1	Dry Bulk Open Storage, Area 1 (Lt.)
DBINS1	Dry Bulk Inside Storage, Area 1 (Lt.)
DBACCESS	Dry Bulk Storage Access; see codes above for ACCFE field
LB1CMAT1	Liquid Bulk Storage Construction - Material 1; A = Aluminum, B = Corrugated Aluminum, C = Asbestos, D = Pre-cast Concrete, E = Concrete, F = Steel, G = Corrugated Steel, H = Metals-Other, I = Wood or Timber, J = Brick or Cinderblock, K = Asphalt, L = Fill, M = Steel Frame, N = Wooden Frame, O = Metal Frame-Other, P = Concrete Frame, Q = Reinforced Concrete, R = Other, S = Steel Piling, T = Timber Piling, U = Concrete Piling
LB2CMAT1	see codes above for LB1CMAT1 field
LBTANK1	Liquid Bulk Storage Tanks, Area 1
LBTANK2	Liquid Bulk Storage Tanks, Area 2
LBSCAP1	Liquid Bulk Storage Capacity, Area 1
LBSCAP2	Liquid Bulk Storage Capcity, Area 2
LBSUPDN1	Liquid Bulk Storage Above/Below Ground; A = Above Ground, B = Below Ground, C = Above/Below Ground
LBACCESS	Liquid Bulk Storage Access; see codes above for ACCFE field
LBHES1	Liquid Bulk Handling Equipment Services; A = Refinery, Plant, Distribution Terminal, B = Distribution Terminal Only, P = Plant Only, R = Refinery Only, X = Refinery and Plant, Y = Refinery and Distribution Terminal, Z = Plant and Distribution Terminal
LBSUNIT1	Liquid Bulk Unit of Storage - Area 1; B = Barrels, G = Gallons, L = Long Tons
LBSUNIT2	Liquid Bulk Unit of Storage - Area 2; B = Barrels, G = Gallons, L = Long Tons
LBSUNIT3	Liquid Bulk Unit of Storage - Area 3; B = Barrels, G = Gallons, L = Long Tons
BGSCAP1	Bulk Grain Storage Capacity, Area 1
BGSCAP2	Bulk Grain Storage Capacity, Area 2
BGACCESS	Bulk Grain Storage Access; see codes above for ACCFE field
OETREG	OET Region Code
LATITUDE	Latitude (decimal degrees)
LONGITUDE	Longitude (decimal degrees)
COUNTER	Record Counter

C.19 WEATHER STATION "WXSTAT" DIRECTORY.

C.19.1 Weather Stations (weather.dbf).

Table C-57. Weather Station metadata codes.

Date of last update	03/04/92

FIELD NAME	FIELD MEANING
WMO_NUMBER	
CALL_SIGN	
SURF_OBS	T/F
LOC_NAME	Location Name
SYNOP_3HR	3-Hourly Synoptic
SYNOP_6HR	6-Hourly Synoptic
SYNOP_OFHR	Off Hourly Synoptic
AERO	Aero Option
AVIATION	Airways
METAR	
RAWIND_SON	Radio Sonde
PIBAL	Pibal
FCST_TAF	Forecast - TAF
FCST_PLATF	Forecast - PLATF
RADAR	Radar
COAST_SMAR	Coastal/Smars
FCST_SH_RG	Short Range Terminal Forecast (12 Hours or Less)
STATE	State Abbreviation
LATITUDE	Latitude (decimal degrees)
NSIND	
LONGITUDE	Longitude (decimal degrees)
EWIND	
ELEVATION	
RESP_AGCY	
UP_AIR_LAT	
UP_AIR_LON	
TYP_LST_CG	
INFO_SRC	
OBS_TYPE	
COUNTER	Record Counter

APPENDIX D

CATS ORGANIZATION AND DESIGN

D.1 INTRODUCTION.

The diagrams in this appendix illustrate the organization and design of the CATS code, as it operates behind its Graphical User Interface (GUI). Possible paths in the CATS coding and information passed between modules are indicated for the various user options that are presented in the CATS menus. When the user chooses a CATS menu option, an initial piece of code (script) is activated, which may, in turn, activate other modules or make calls to the operating system.

A code **module** is a routine or subroutine written in a compilable or script language, which performs a desired task. A **call** is a code statement that causes another module to be invoked. A call may contain one or more **arguments**, each of which is a data element. Arguments pass this data to the module called, where it may be used or manipulated. A return statement within a module causes to terminate and relinquish control to the calling routine, possibly with accompanying data. CATS code modules are typically scripts, written using the ArcView Avenue macro language. Calls to Avenue scripts have the form Av.Run("module name", {arguments}). Another type of CATS module is a dialog. Dialogs operate using buttons in a GUI window. When a button is pushed, an Avenue script or another dialog may be activated. This is similar to activating the initial script from a CATS menu choice. Dialogs are invoked with a call of the form Av.FindDialog("module name"). Another type of call made in the CATS coding is a call directly to the operating system. These calls have the form System.Execute(arguments). System calls may launch DLL's or cause other code systems such as ALOHA or OSSM to run outside CATS. A return of information may have the form Return argument.

CATS functionality is illustrated using the following conventions:

Modules are shown encased in double lines.
Calls from one module to another and button choices within dialogs are shown encased in faint lines.
Arguments (pieces of information) passed in the calls are usually within brackets { } or parentheses ( ).

Additional notations regarding the code which may appear with the diagrams include comments on the purposes of code modules, Return statements, and indications of referenced global variables.

D.2 CATS CONTROL MENU.

D.2.1 CATS Preferences Option.

function
Allows the user to view or edit directory locations for important CATS resources.

associated code:
initial script

CATS.CONTROL.SETPREF

av.Run("CATS.UTIL.MKDIR",{catscwd})

CATS.UTIL.MKDIR

New DLL function call scripts to make a directory and start a crystal report via background dll call and eliminated the need for executesynchronous avenue construct to command shell.

' AVENUE to DLL CALL to make a new directory
' if directory exists - call fails gracefully
' at this time; string that is passed should include
' full path

return status

CATS.Control.SetGUI
globals
_hasALOHA
_hasCHAS
_hasHPAC

CATS.Control.SetGUI

av.Run("CATS.Control.SetGui","")

System.SetEnvVar("ARCHOME",(_catsdata + "\libs"))

System.SetEnvVar("CATSSTAT",(_catsdata))

System.SetEnvVar("POLYHOME",(_polydata))

System.SetEnvVar("ESRISMHOME", (_esrism))

CATS.CONTROL.SETPREF
globals
_catsdata = "CATS Data:"
_catrt = "CATS Real-Time Data:"
_polydata = "CATS Polygon Population Data by State:"
_cleanflag.AsString = "Auto CleanUp [true|false]:"
_pccom = "MSPROMPT Startup String:"
_canftp.AsString = "Internet Access [true|false]:"
_aloha = "ALOHA HOME directory:"
_esrism = "ESRI Street Map Data (.bms) File:"
_hpac = "HPAC HOME directory:"
_pSigma.AsString = "HPAC Contour Prob.(0.00 - 1.00):"
_curusrdir = "CATS WORKING DIRECTORY"
_catshome
_catsversion
_hasHPAC
_hasALOHA

D.2.2 Create Scenario Options

function
Open a new CATS scenario and load all default backgroud data.

associated code:
initial script

CATS.Util.ViewCreate

av.Run("View.ZoomToThemes","")

View.ZoomToThemes

CATS.Util.ViewCreate
' Create the new view
globals
_catsdata

D.2.3 Open CATS Scenario Option

function
Recall an existing scenario that has been saved to disk.

associated code:
initial script

CATS.CONTROL.ReadScenario

globals
_curusrdir

D.2.4 Save CATS Scenario Option

function
Save the contents and format of the active View scenario in the current directory, under its current name.

associated code:
initial script

CATS.CONTROL.SaveScenario

' save scenario to save currently active view to ODB in curusrdir
globals
_curusrdir

D.2.5 Add Haz Above Option

function
Places an index, labeled HAZ above, in the Table of Contents of the current view. All hazard themes are loaded above this index.

associated code:
initial script

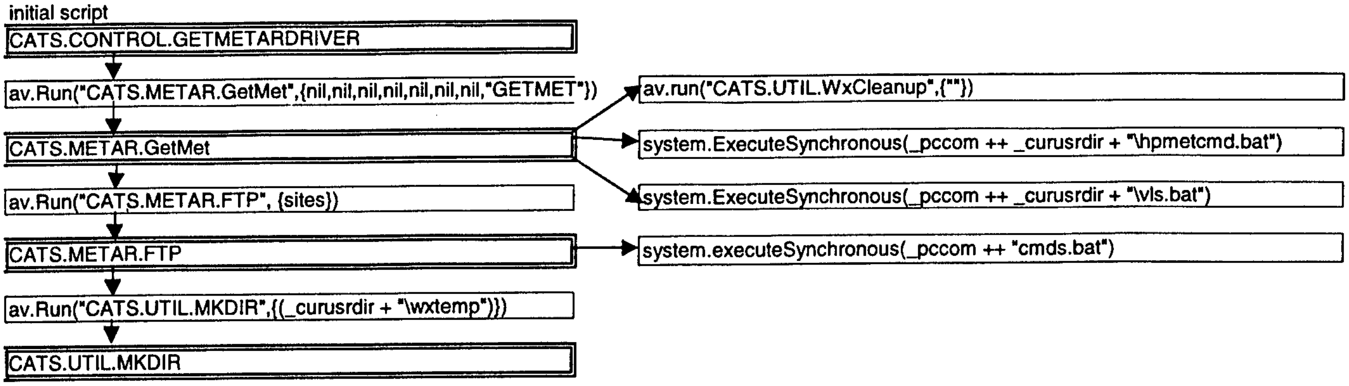
CATS.Control.AddHazabove

globals
_curusrdir
_catsdata

D.2.6 Get Weather Option

function
Allows the user to obtain current weather conditions from reporting stations within half a degree of a specified location.

associated code:
initial script



CATS.METAR.GetMet
globals
_curusrdir
_theGlobX
_theGlobY
_catsdata
_catrt
_hascal
_pccom
_chas

CATS.METAR.FTP
globals
_curusrdir
_catshome
_catrt
_pccom

D.3 HAZARD MENU

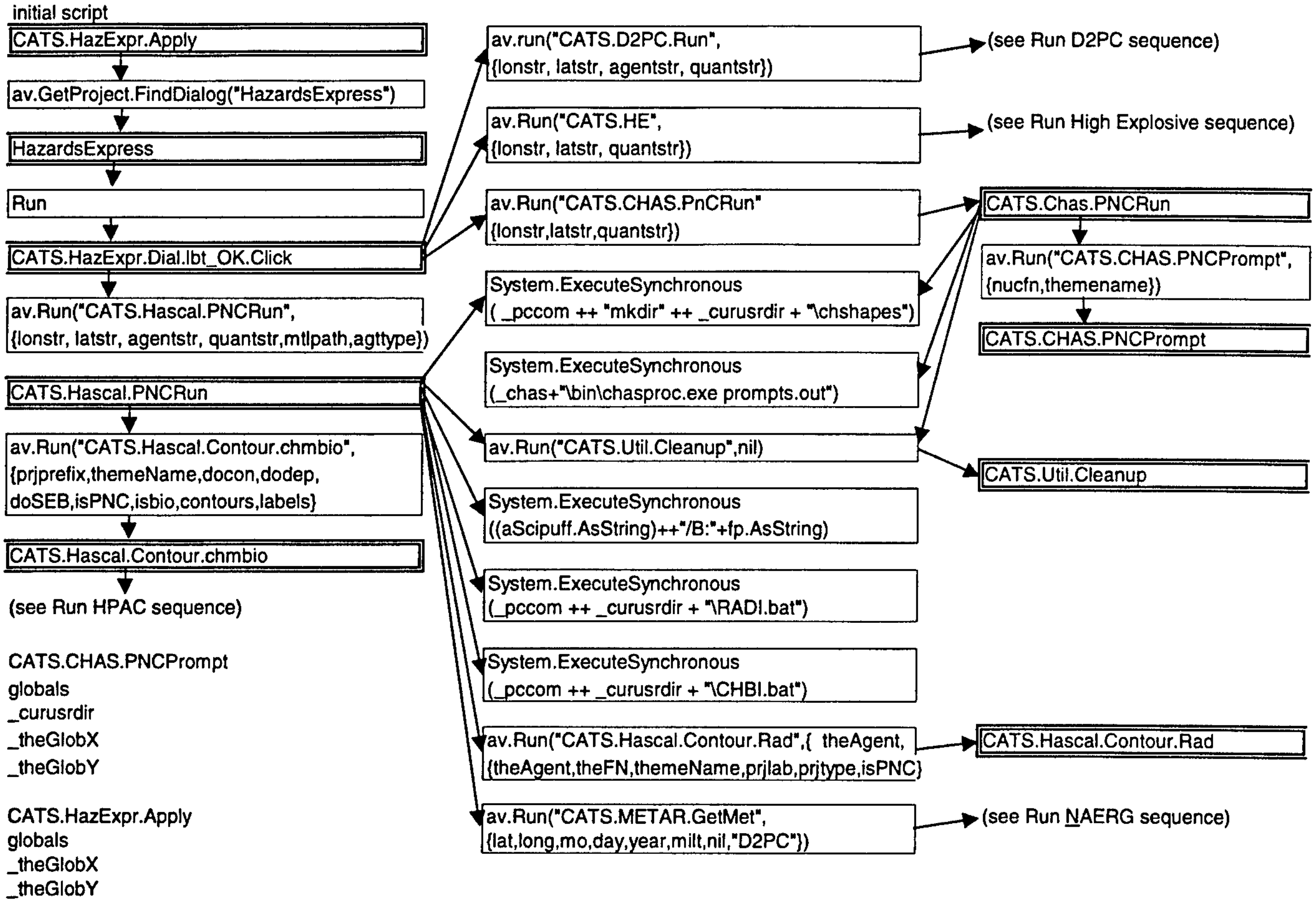
D.3.1 Rapid Hazard Analysis

function:
Allow estimations for technological hazards using simplified input.

rapid hazard analysis tool
toxic industrial materials
chem/bio weapon agents
radiological weapon
high explosives

inputs:
latitude, longitude,agent,quantity
weather:
wind speed, wind direction, cloudiness, temperature

associated code:
initial script



D.3.2 Run Hazard Area

function:
Allows a hazard area of arbitrary shape and size to be loaded into the active View, based on graphic objects created by the user.

draw graphic tool

associated code:
initial script

CATS.KeepOut.Main

return hazareaname

D.3.3 Run High Explosive

function:
Estimate the collateral damage as the result of a large explosion.

inputs:
lbs tnt
latitude
longitude

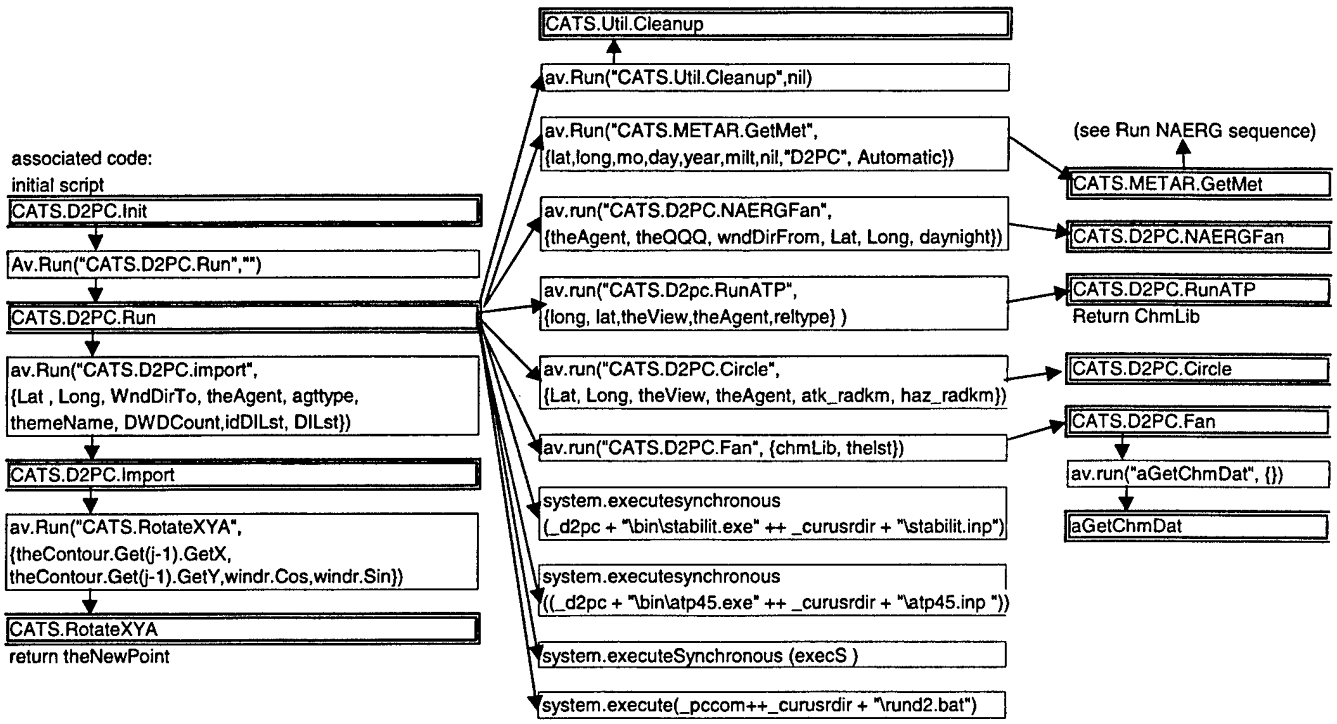
associated code:
initial script

CATS.He

D.3.4 Run D2PC

function:
Run the D2PC code to calculate hazards from explosions or spills of military agents or TIMs. An Allied Technical Protocol (ATP-45) initial hazard zone (fan) is also generated. For TIMS, an NAERG fan is created as well.

inputs:
substance, quantity, name of D2PC theme, latitude, longitude, date, time, explosion/spill
weather: wind speed, wind direction, cloudiness, temperature



D.3.5 Run ALOHA

function:
Initiate calculations by the EPA code ALOHA.

hazard origin tool

associated code:
initial script

CATS.ALOHA.RUN

```
system.execute( (_catshome + "\tech_haz\aloha\bin\aloha_com" ++ _curusrdir) )
```

```
system.execute( (_aloha + "\aloha.exe") )
```

D.3.6 Run CHAS NUC

function:
Initiate nuclear hazard calculations by the Comprehensive Hazard Assessment System (CHAS).

inputs:
description, latitude, longitude, date, time, delivery system, burst height, yield, fission fraction, environment, elevation, pressure, wind direction, temperature, relative humidity, wind speed

associated code:
initial script

CATS.CHAS.Nucrun

Executes CHAS, then loads output and ATP45 into current view

av.Run("CATS.CHAS.ATP45Draw", { theATPFileName, themeName, theDot3, theFileName})

CATS.CHAS.ATP45Draw

av.run("CATS.ATP45.NucFan", NucLib)

CATS.ATP45.NucFan

Processes ATP-45 Hazard Zones for Dispersion Effects Following a Nuclear event
'Called From: ATP45.Draw

CATS.CHAS.Nucload

av.Run("CATS.CHAS."+theDot3+"Load", {theFileName, themeName, outFileName})

system.execute(_pccom ++ _chas+ "\bin\nbc2shap.exe" ++ theResName.AsString ++ _curusrdir+"\chshapes\"+theFNString)

system.execute(_pccom ++ _chas + "\bin\chas" ++ _catshome ++ "N")

system.executeSynchronous (_pccom ++ "mkdir" ++ _curusrdir + "\chshapes")

av.Run("CATS.CHAS.Prompt", {theFileName, themeName})

CATS.CHAS.Prompt

D.3.7 Run CHAS BIO

function:
Initiate biological hazard calculations by the Comprehensive Hazard Assessment System (CHAS).

inputs:
description, latitude, longitude, date, time,
delivery system, munition, elevation, pressure,
wind direction, temperature, relative humidity, wind speed
cloudiness, ground roughness

associated code:
initial script

CATS.CHAS.Biorun

' Executes CHAS, then loads output and ATP45 into current view

av.Run("CATS.CHAS.ATP45Draw",
{ theATPFileName, themeName, theDot3, theFileName})

CATS.CHAS.ATP45Draw

av.run("CATS.ATP45.GetBioDat", {infile})

CATS.ATP45.GetBiodat

Return BioLib

(see Run NAERG sequence)

CATS.METAR.GetMet

av.Run("CATS.METAR.GetMet", {nil,nil,nil,nil,nil,nil,nil,"CHAS"})

system.execute(_pccom ++ _chas + "\bin\chas" ++ _catshome ++ "B")

system.executeSynchronous
(_pccom ++ "mkdir" ++ _curusrdir + "\chshapes")

av.Run("CATS.CHAS."+theDot3+"Load",
{theFileName, themeName, outFileName})

CATS.CHAS.bioload

system.execute(_pccom ++ _chas+"\bin\nbc2shap.exe"
++ theResName.AsString ++ _curusrdir+"\chshapes\"+theFNString)

av.run("CATS.ATP45.Circle" , CircDat)

CATS.ATP45.Circle

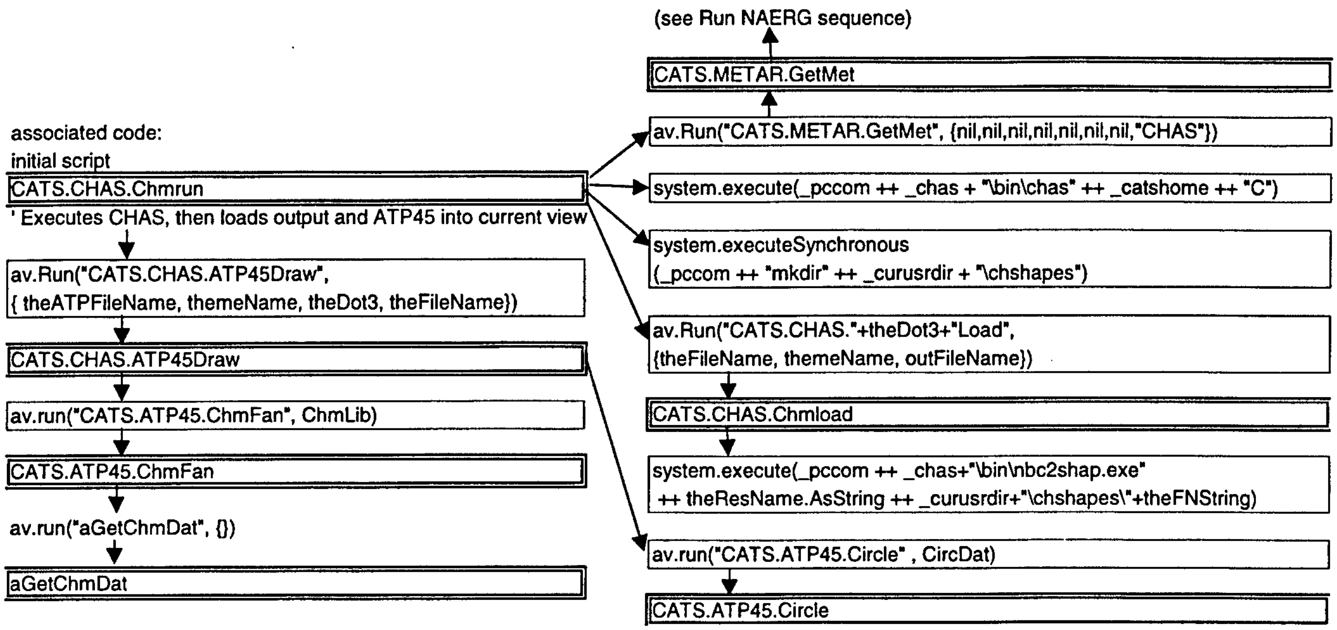
av.run("CATS.ATP45.BioFan", {BioLib, PrefixLst})

CATS.ATP45.BioFan

D.3.8 Run CHAS CHEM

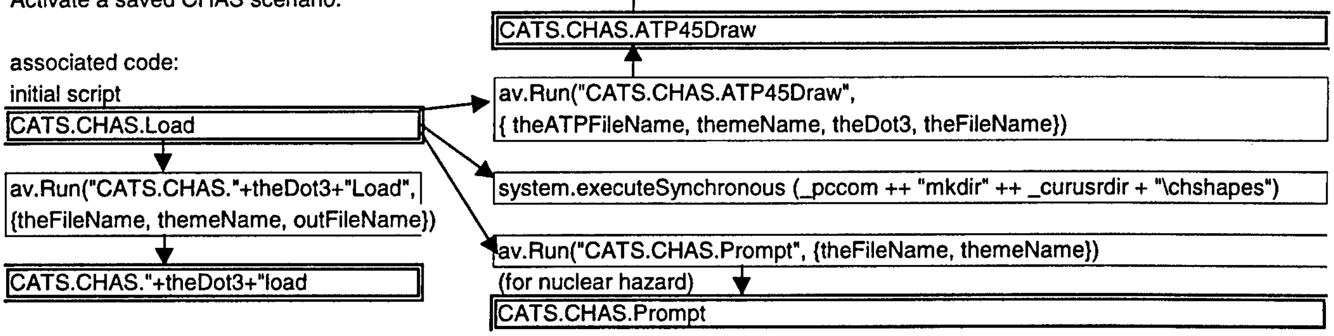
function:
Initiate chemical hazard calculations by the Comprehensive Hazard Assessment System (CHAS).

inputs:
description, latitude, longitude, date, time,
delivery system, munition, elevation, pressure,
wind direction, temperature, relative humidity, wind speed
cloudiness, ground roughness



D.3.9 Load CHAS

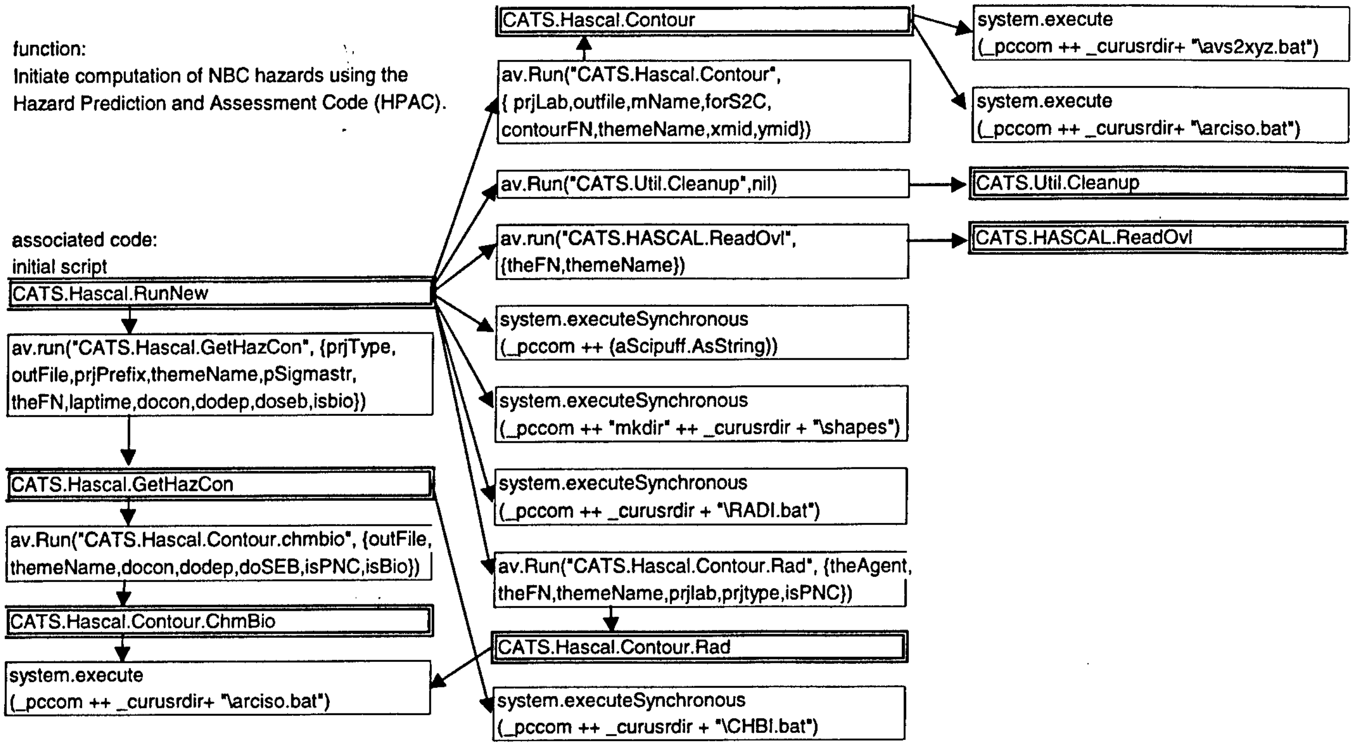
function:
Activate a saved CHAS scenario.



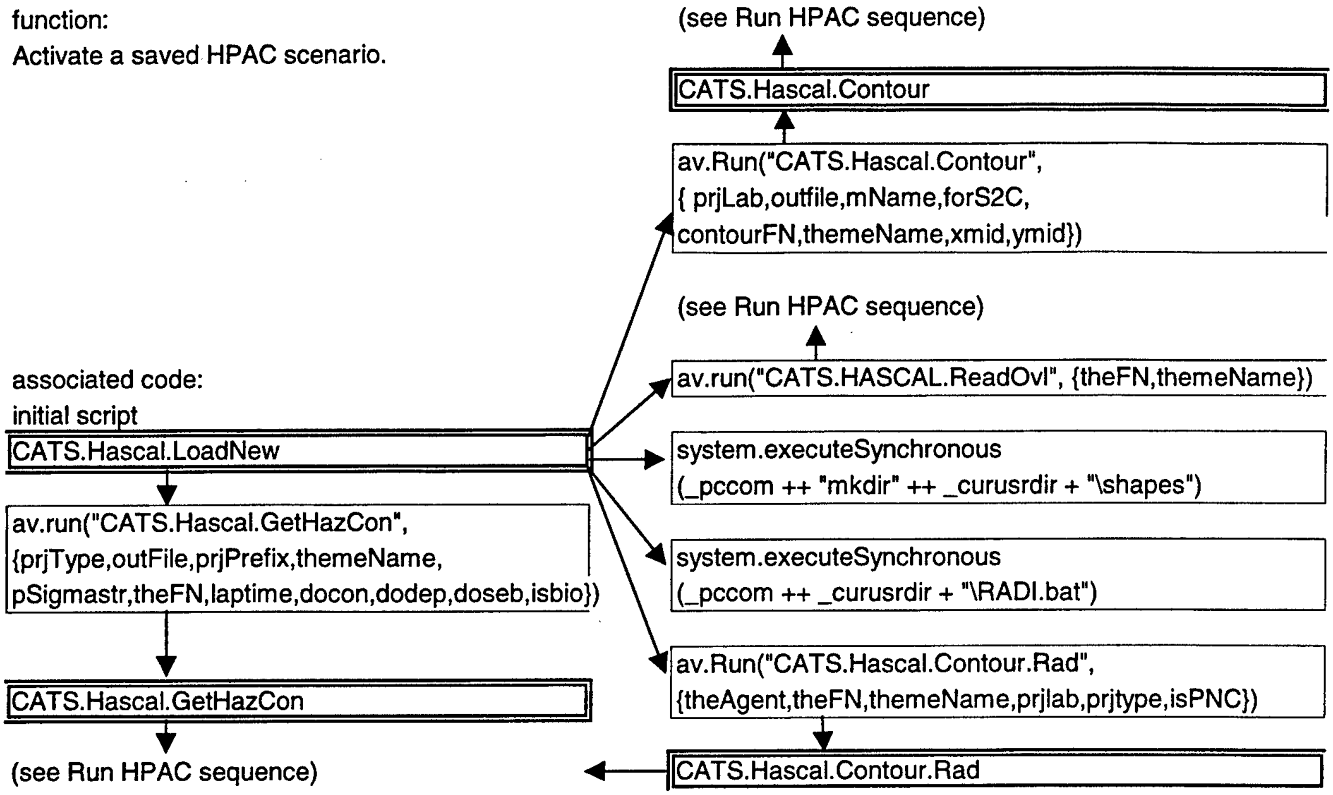
D.3.10 Run HPAC

function:
Initiate computation of NBC hazards using the Hazard Prediction and Assessment Code (HPAC).

associated code:
initial script



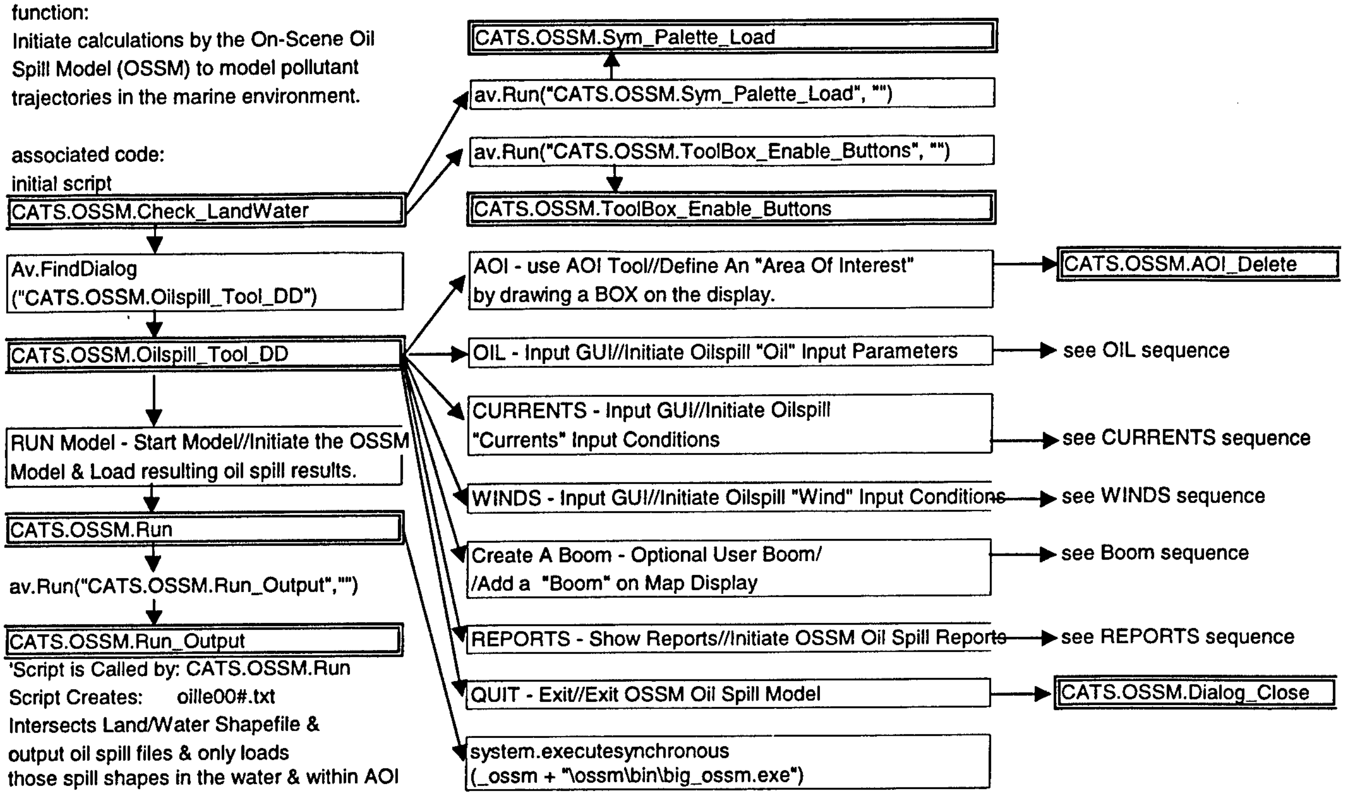
D.3.11 Load HPAC



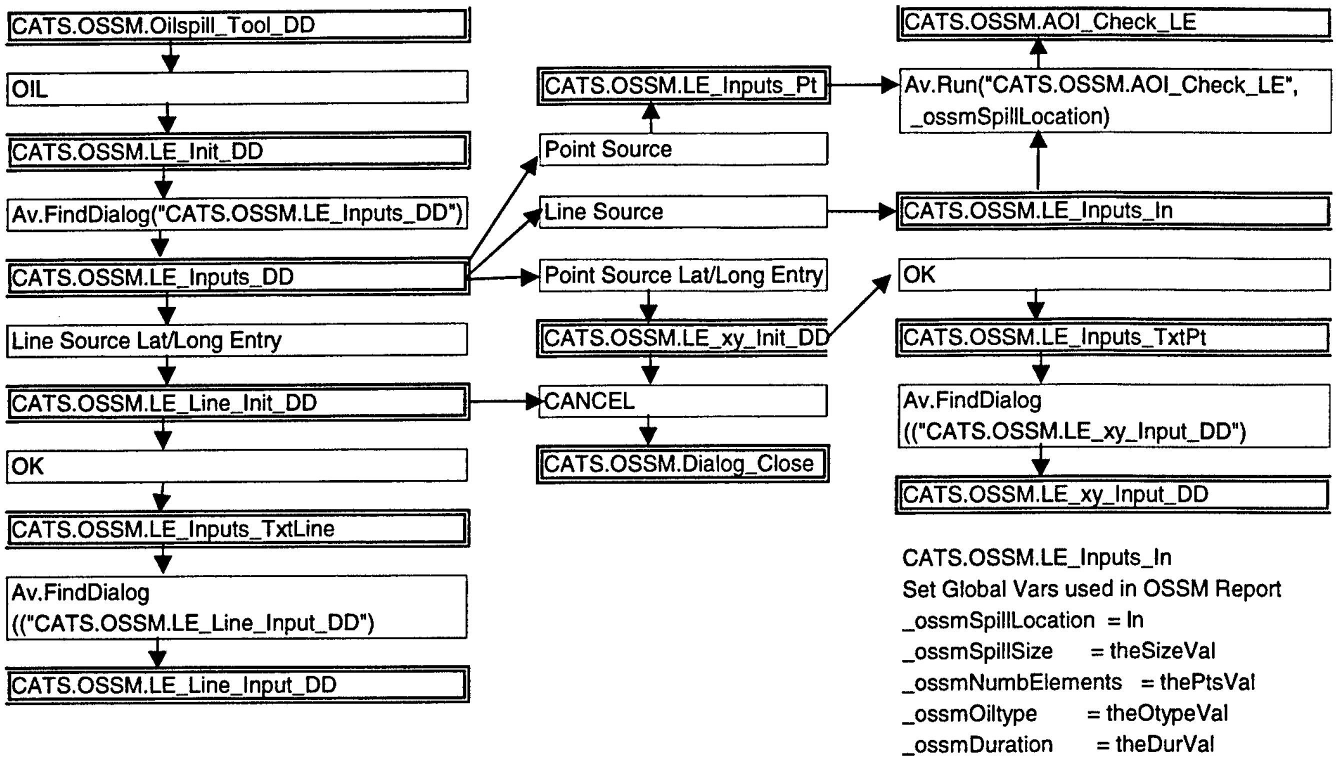
D.3.12 Run OSSM/Oil Spill

function:
Initiate calculations by the On-Scene Oil Spill Model (OSSM) to model pollutant trajectories in the marine environment.

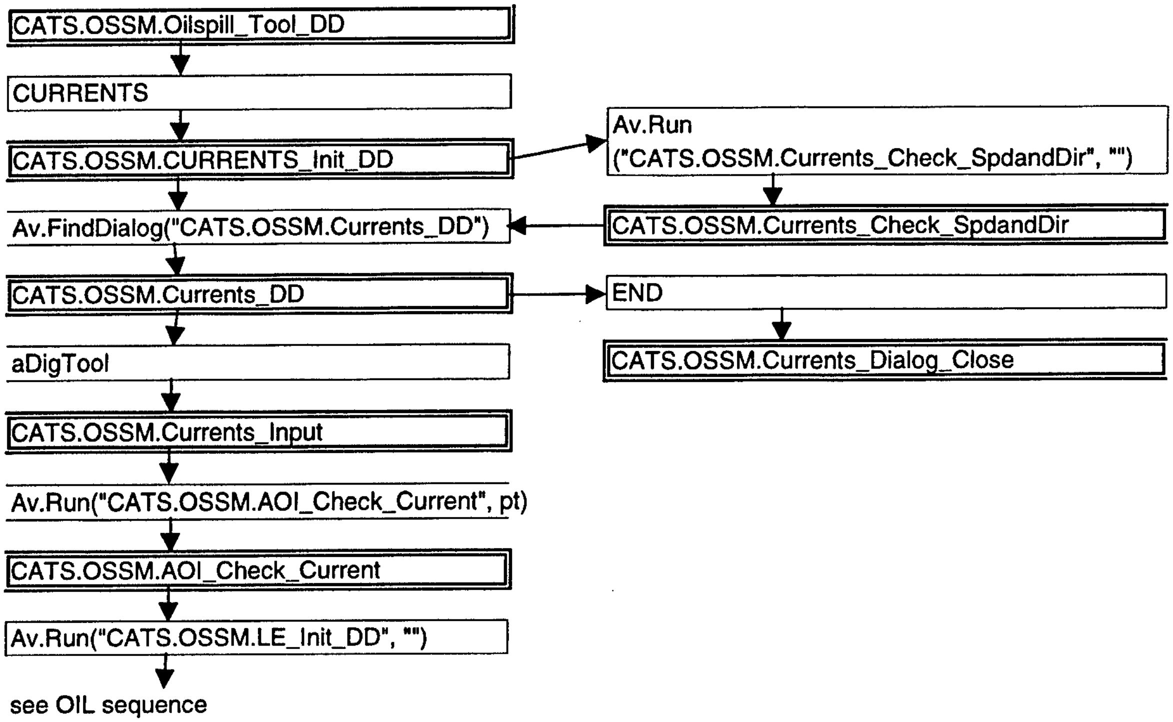
associated code:
initial script



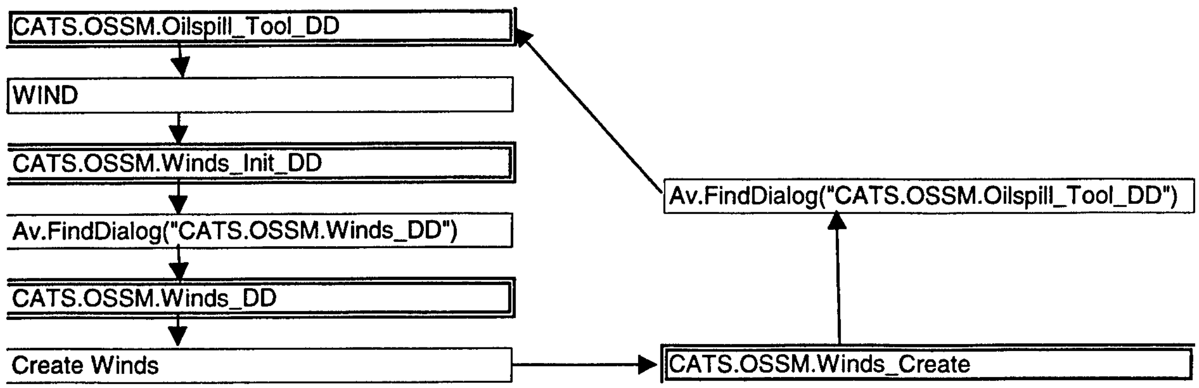
D.3.12.1 Oil Sequence



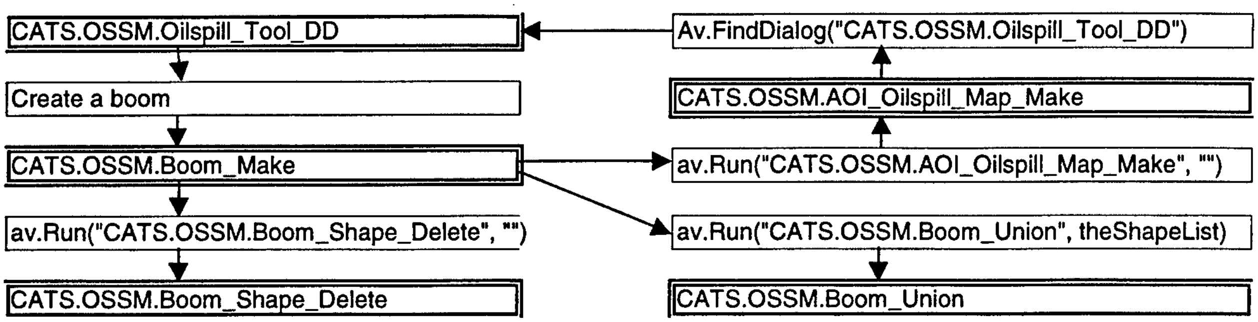
D.3.12.2 Currents Sequence



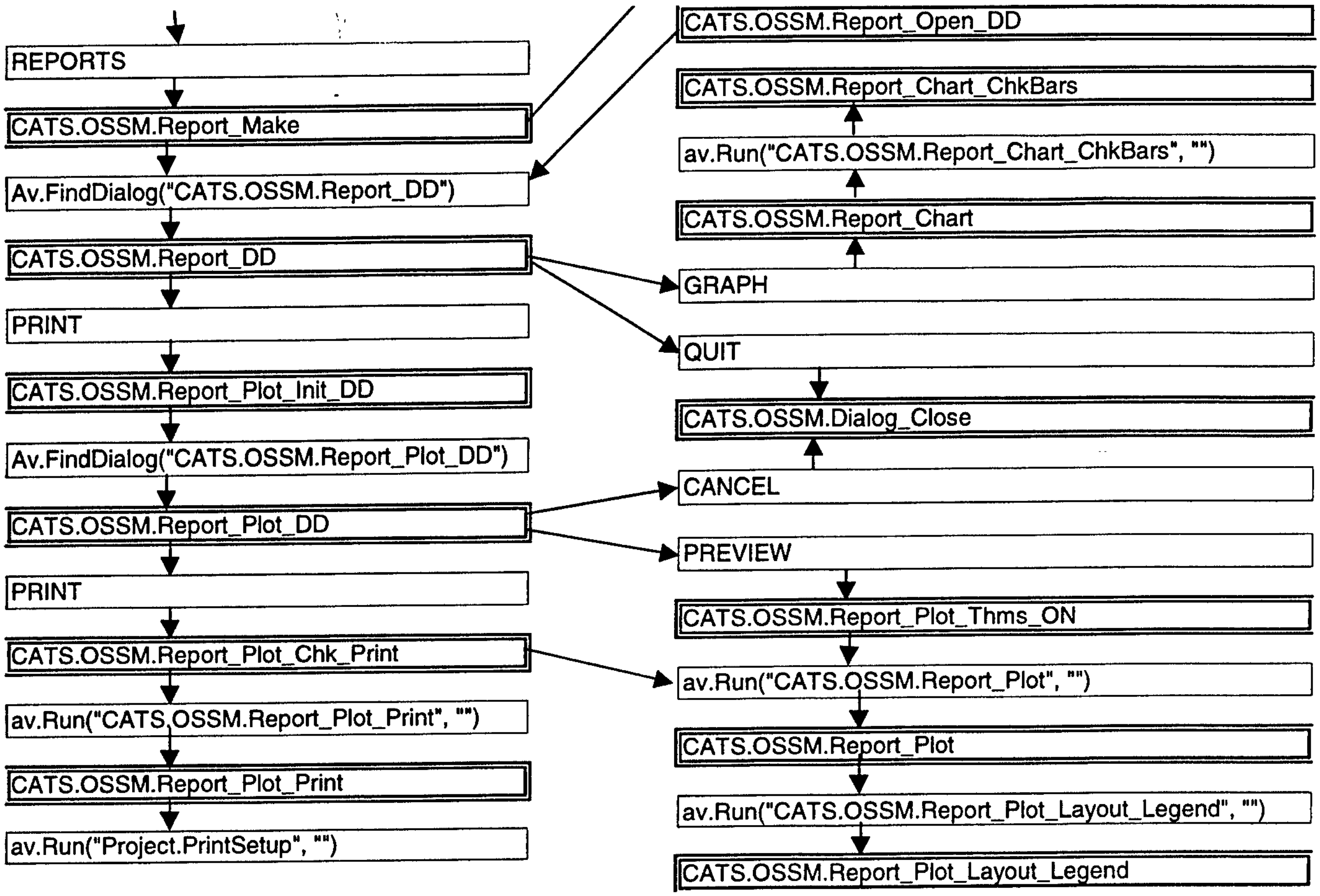
D.3.12.3 Winds Sequence



D.3.12.4 Boom Sequence



D.3.12.5 Reports Sequence



D.3.13 Run Hurricane

function:
Initiate calculations by the hurricane model to predict the storm track and wind damage.

associated code:
initial script

```
CATS.Hurr.WindCompute
    av.Run("CATS.Hurr.WindTrack", {"h", theName})
        CATS.Hurr.WindTrack
        return theFTheme

CATS.Hurr.WindCompute calls:

av.Run("CATS.Hurr.WindDamage", {theView, theName, True})
    CATS.Hurr.WindDamage

AV.Run("CATS.Hurr.GetNameNumber", {theMad})
    CATS.Hurr.GetNameNumber
    return theName + "." + theNumber

av.Run("View.ZoomtoThemes","")
    View.ZoomtoThemes

System.Execute("go.bat")

System.Execute(_pccom++ _catshome +
"\cats_stat\bin\mkdir" ++ _cursrdir + "\" + theName)

System.Execute(_pccom++ _catshome +
"\cats_stat\bin\rm" ++ "-r" ++ _curusrdir + "\" + theName)

System.ExecuteSynchronous(_pccom++ _catshome +
"\cats_stat\bin\mv track.pts" ++ _curusrdir + "\" + theName)

System.ExecuteSynchronous(_pccom++ _catshome +
"\cats_stat\bin\mv track.atr" ++ _curusrdir + "\" + theName)

System.ExecuteSynchronous(_pccom + _curusrdir + "\go.bat")
```

D.3.14 Run Hurricane Uncertainty

function:

Allow users to determine damage probabilities as a function of the uncertainty associated with a given hurricane track forecast

associated code:

initial script

```
CATS.Hurr.Uncertainty
```

```
av.Run("CATS.Hurr.WindTrack", {"h", theName})
```

```
CATS.Hurr.WindTrack
return theFTheme
```

```
AV.Run("CATS.Hurr.GetNameNumber", {theMad})
```

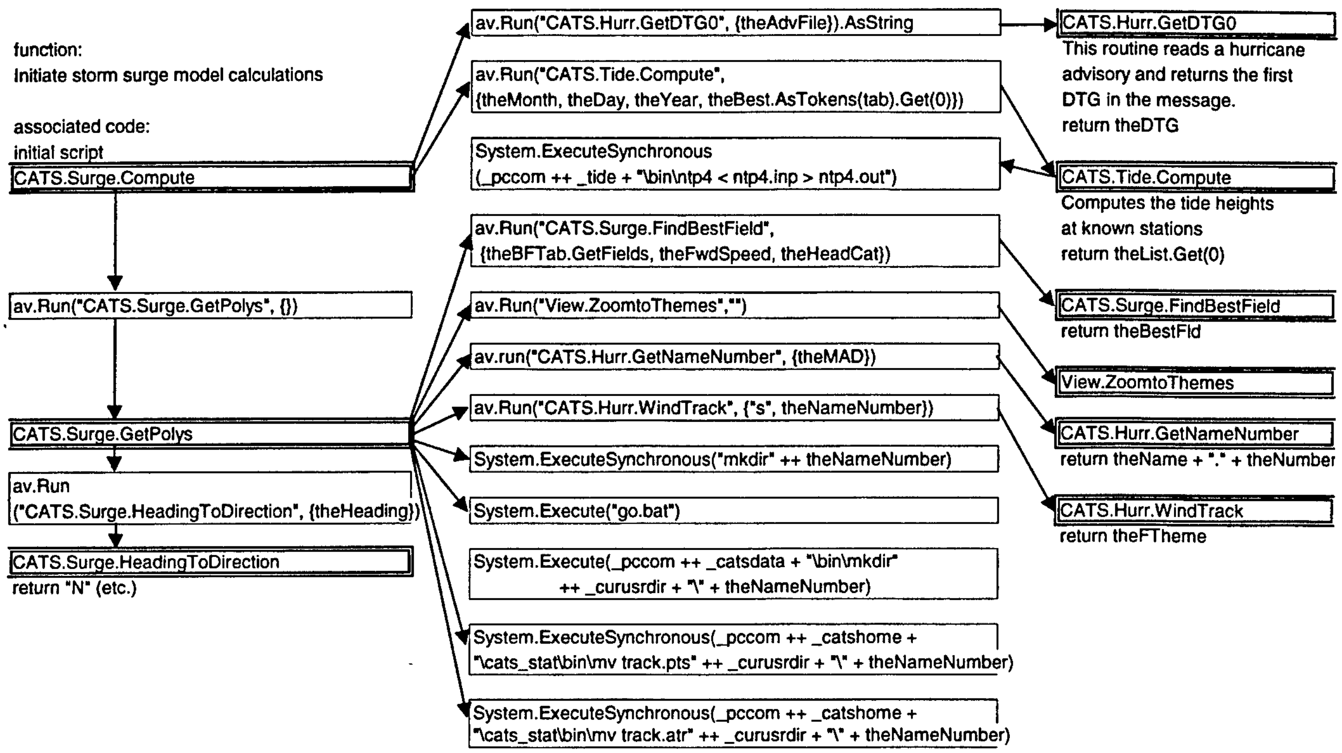
```
CATS.Hurr.GetNameNumber
return theName + "." + theNumber
```

```
System.Execute(_pccom++ _catshome +
"\cats_stat\bin\mkdir" ++ _curusrdir + "\" + theName)
```

```
System.Execute("go.bat")
```

CATS.HurrUnc.Compute

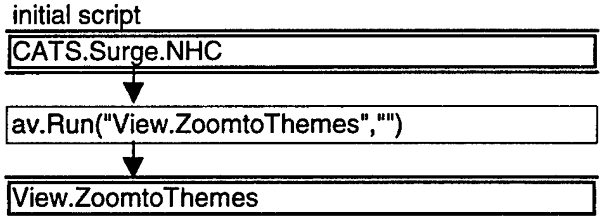
D.3.15 Run Surge



D.3.16 Run NHC Surge

function:
Convert National Hurricane Center (NHC) surge
estimate file for display in a view window.

associated code:
initial script



D.3.17 Run Earthquake

function:
Initiate Earthquake Model estimations of damage to facilities, infrastructure, and population at risk.

earthquake damage area tool
hazard origin tool
fault selection tool

inputs:
magnitude
fault angle
latitude
longitude
name

associated code:
initial script

CATS.EQ.Compute

av.Run("CATS.EQ.ProbCompute", {theView, theName})

CATS.EQ.ProbCompute

av.run("CATS.Eq.JointProb", {theMixList, theMMIGridList, theCode, theView, theEventName})

CATS.EQ.JointProb
return thePTheme

av.Run("CATS.Eq.Find4k", {theParams.Get(3).AsNumber@theParams.Get(2).AsNumber})

CATS.EQ.Find4K
return the4K

System.ExecuteSynchronous(_pccom ++ "go.bat")

System.ExecuteSynchronous(_pccom ++ _catsdata + "\bin\mkdir" ++ theName)

av.Run("CATS.EQ.DFCompute", {theView, theName})

CATS.EQ.DFCompute

System.ExecuteSynchronous(_pccom ++ _eq + "\bin\dmgfactor" ++ "dmgfactor.inp dmgfactor.txt")

System.ExecuteSynchronous(_pccom + _catsdata + "\bin\rm -f spoly.* dmgfactor.* final.* shift.dbf")

av.Run("CATS.Eq.DoPrbDmg", {thePolyFTheme, theMixList, theCode})

CATS.EQ.DoPrbDmg

D.4 CONSEQUENCE MENU

D.4.1 Pop. Effects

function:
Calculate the expected population affected by affected by casualty-producing environments or residence damage.

associated code:
initial script

CATS.CONSEQ.PopAffected

av.run("CATS.CONSEQ.ExpectedPopPoints", {thedemog})

CATS.CONSEQ.ExpectedPopPoints
Computes the expected population for each of several levels.
Acts on the currently selected theme.

av.run("CATS.CONSEQ.OtherPointRollup", {"paffect.shp", theType, theDmgTheme.GetName, admin1, admin2, p100fldname})

CATS.CONSEQ.OtherPointRollup
return theOutputFN

av.run("CATS.CONSEQ.ExpectedPopPolys", {sno, p100})

CATS.CONSEQ.ExpectedPopPolys

av.run("CATS.CONSEQ.ExpectedPopGrid", {Grid.MakeSrcName(sn), p100})

CATS.CONSEQ.ExpectedPopGrid

av.Run("CATS.CONTROL.MAPMOD2CSQ", {"Consequence Population Effects"})

CATS.CONTROL.MAPMOD2CSQ
'Reads the scenario Table of Contents Searchs, extracts, and parses all the comment fields. Does a lookup between the global dictionary _modtruthdic. Determines which model output themes are appropriate to a consequence and RRS.

av.run("CATS.CONSEQ.NHPointRollup", {"paffect.shp", theType, theDmgTheme.GetName, admin1, admin2, theStructType})

CATS.CONSEQ.NHPointRollup
return theOutputFN

System.Execute (_pccom ++ "notepad" ++ theReport.AsString)

System.Execute (_pccom ++ _catsdata + "\bin\rm -f" ++ "cenclip.* dmgclip.* paffect.* pfull.dbf")

D.4.2 Pop. At Risk

function:
Calculate the total number of persons within hazard areas.

associated code:
initial script

```
CATS.CONSEQ.PopAtRisk  ──▶  System.Execute("notepad" ++ "popatrisk.txt")
' Creates a report of pop at risk consequences from a hazard.
        ↓
av.Run("CATS.CONTROL.MAPMOD2CSQ",{"Consequence Population At Risk"})
        ↓
CATS.CONTROL.MAPMOD2CSQ
'Reads the scenario Table of Contents
Searchs, extracts, and parses all the
comment fields. Does a lookup between
the global dictionary _modtruthdic.
Determines which model output themes are
appropriate to a consequence and RRS
```

D.4.3 Infrastructure (at Risk)

function:
Calculate the number of assets such as hospitals, airports, radiostations, etc.,, within hazard areas.

associated code:
initial script

```
CATS.CONSEQ.Infrastructure  ──▶  System.Execute("notepad" ++ "infra.txt")
' Creates a report of infrastructure consequences from a hazard.
        ↓
av.Run("CATS.CONTROL.MAPMOD2CSQ",{"Consequence Infrastructure At Risk"})
        ↓
CATS.CONTROL.MAPMOD2CSQ
'Reads the scenario Table of Contents
Searchs, extracts, and parses all the
comment fields. Does a lookup between
the global dictionary _modtruthdic.
Determines which model output themes are
appropriate to a consequence and RRS
```

D.4.4 Housing At Risk

function:
Calculate multi-family, single-family,
and mobile homes within hazard areas.

associated code:
initial script

```
CATS.CONSEQ.HousingAtRisk  --->  System.Execute("notepad" ++ "huatrisk.txt")
' Creates a report of housing at risk consequences from a hazard.
        |
        v
av.Run("CATS.CONTROL.MAPMOD2CSQ",{"Consequence Housing At Risk"})
        |
        v
CATS.CONTROL.MAPMOD2CSQ
'Reads the scenario Table of Contents
Searchs, extracts, and parses all the
comment fields.  Does a lookup between
the global dictionary _modtruthdic.
Determines which model output themes are
appropriate to a consequence and RRS
```

D.5 RESPONSE RESOURCE SUSTAINABILITY (RRS)

D.5.1 Initial Resources Needed

D.5.1.1 Preparation

function:
Compute the number of persons affected
in all three residential housing types and
at all three levels of damage severity.

associated code:
initial script

```
CATS.CONSEQ.RRSPREP  --->  System.ExecuteSynchronous
                           (_pccom ++ _catsdata + "\bin\rm -f cenclip.* pop.* foo.* sum0.dbf sum1.dbf sum2.dbf")
                     --->  System.Execute
                           (_pccom ++ _catsdata + "\bin\rm -f cenclip.* pop.* foodmg*.* foo.* sum0.dbf sum1.dbf sum2.dbf")
```

D.5.1.2 Calculation

function:
Calculate resources needed for
individual or all housing types.

associated code:
initial script

```
CATS.RRS.planning_factor_calc
```

D.5.1.3 Initial Resource Background Document

function:
Provide text describing RRS
initial resource analysis.

associated code:
initial script

```
CATS.RRS.notes
```

D.5.2 Resource Queries

D.5.2.1 Initialize Site Query

function:
Establish initial conditions for resource queries; type of aircraft,
distance from damage band, minimum warehouse space,
military landing rights verification

associated code:
initial script

```
CATS.RRS.Setpref
av.Run("CATS.RRS.MAPHAZ2RRSFLDS",{hazardtype})
CATS.RRS.MAPHAZ2RRSFLDS
'RRS function to read the rrsflds field from the _modtb global dictionary
'Input Parameters:
'  hazardtype - CATS HAZARD TOKEN - AV string object
return ({rrsflds})
  rrsflds - list of applicable consequence fields for
RRS - av tokenized string object (delimter ":")
```

```
av.Run("CATS.CONTROL.MAPMOD2CSQ",
{"Resources, Response, & Sustainability"})
CATS.CONTROL.MAPMOD2CSQ
'Reads the scenario Table of Contents
Searchs, extracts, and parses all the
comment fields.  Does a lookup between
the global dictionary _modtruthdic.
Determines which model output themes are
appropriate to a consequence and RRS
```

D.5.2.2 Find Potential Mobility Sites

function:
Determine the location of mobility sites:
Airport-Warehouse combinations

associated code:
initial script

CATS.RRS.SelectMobAir

av.Run("CATS.CONTROL.DEACTIVATETHEMES", {theView})

CATS.CONTROL.DEACTIVATETHEMES
' SET all themes inActive

av.run("CATS.RRS.Cleanup_Graphics",{theView})

CATS.RRS.Cleanup_Graphics

av.run("CATS.RRS.kill_select_mob_sites","")

CATS.RRS.kill_select_mob_sites
Removes ALL the
"Selected Mobility Sites"
Table(s) from the Project for "CLEANUP"
' modified to kill any tables related to RRS

av.Run("CATS.RRS.distance2", {theView,thenewFTABMOB, thenewFTABAIR})

CATS.RRS.distance2
Find the Closest (Selected) Airport
to the (Selected) Warehouse

av.Run("View.ZoomToThemes","")

View.ZoomToThemes

D.5.2.3 Find Commodity Resource Sites

function:
Determine the location of commodities sources.

associated code:
initial script

CATS.RRS.Selectcommodity

av.Run("CATS.CONTROL.DEACTIVATETHEMES",{theView})

CATS.CONTROL.DEACTIVATETHEMES
' SET all themes inActive

D.5.2.4 Find Disaster Medical Assistance Team (DMAT) Resource Sites

function:
Determine the location of sources that may provide commodities
that support disaster medical assistance teams.

associated code:
initial script

CATS.RRS.SelectDMAT

av.Run("CATS.CONTROL.DEACTIVATETHEMES",{theView})

CATS.CONTROL.DEACTIVATETHEMES
' SET all themes inActive

D.5.2.5 Roadblocks

function:
Provide graphic and tabular descriptions of street addresses, closure at which isrequired to interdict a hazard area.

associated code:
initial script

CATS.Conseq.RoadBlocks

av.run("CATS.Control.MapMod2Csq",
{"Consequence Transportation At Risk"})

CATS.CONTROL.MAPMOD2CSQ

'Reads the scenario Table of Contents
'Searchs, extracts, and parses all the comment fields
'Does a lookup between the global dictionary _modtruthdic
'determines which model output themes are appropriate
'to a consequence and RRS
'Note the global dictionary is produced in startup by
'calling CATS.CONTROL.MODELTAB

av.run("CATS.Conseq.SelectAllDrawn", {t})

CATS.Conseq.SelectAllDrawn

av.run("CATS.KeepOut.Main",
{(t.getname + ":RoadBlockBufferZone" ++ bufdiststr + "ft")})

CATS.KeepOut.Main

return hazareaname

APPENDIX E

REQUEST FOR CATS SOFTWARE

CATS (Consequences Assessment Tool Set) software is available for the analysis of hazards and consequences associated with natural and technological disasters, including hurricanes and earthquakes, as well as hazardous materials, nuclear, chemical, and biological agent releases. CATS is available for use by government agencies and government-sponsored, private companies involved in emergency response and management. The CATS application operates within the ArcView® 3 (Version 3.1 or later) Geographical Information System (GIS) with Spatial Analyst Extension 1.1 or later, products of from Environmental Systems Research Institute, Inc. (ESRI). The use of ESRI Streetmap 1000 in conjunction with CATS is also recommended.

Please go to either of the following websites and follow the links as required to find the request-for-software form.

http://cats.saic.com
https://register.dtic.mil/wobin/WebObjects/DTRA_reg

Note that CATS is provided as on single-seat license basis and is subject to export restrictions.

Requestors possessing the required GIS software and wishing to receive the CATS software, but having questions about the process should contact:

Mary Beth Christianson, SAIC CATS Customer Support
Science Applications International Corporation
10260 Campus Point Drive
San Diego, CA 92121-1578
Phone: 858-826-6822
Fax: 858-826-6174

Requestors wishing to obtain the Geographical Information System (GIS) software required to run CAT-JACE should contact:

Russ Johnson, ESRI Public Safety Manager
Environmental Systems Research Institute, Inc.
380 New York St.
Redlands, CA 92373-8100
Phone: 909-793-2853, ext. 1-1836
Fax: 909-307-3039

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ATTN: USD/P

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UNIT 30400 BOX 1000
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ATTN: ECJ2-O-T
ATTN: ECJ5-N
ATTN: ECJ5D

COMMANDER
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APO NEW YORK 09128-4209
ATTN: ECJ-6

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